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The Journal of Bone & Joint Surgery

ARMY EXPERIENCES WITH TENDON TRANSFERENCE.

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In civilian practice previous to the recent Great War, attempts at restoration of function by muscle transference had been very largely limited to the lower extremity.

This was probably due to the fact that all movements of the upper extremity, particularly in the forearm and hand, are so complicated and exact, and the muscles controlling these movements so numerous, that it did not appear feasible so to adjust the transferred muscles that these finer and essential movements might be preserved. The war, however, brought the surgeon face to face with a problem never before encountered in any such wholesale fashion, and when the great group of cases presented themselves with deformed and disabled limbs due to irreparable nerve injuries, necessity proved the stimulus required and for the most part these disabilities have been overcome, and useless members have been changed to functioning ones more or less perfect.

In some cases the end-results, so far as the restoration of function is concerned, are so nearly perfect that one feels that so good a substitute has been provided in such irreparable peripheral nerve lesions as to make it a matter of small concern if a purely motor nerve were restored or not.

The function of a limb also may be often restored in eight or ten weeks by muscle transference which could not be procured, if nerve suture were successful, in less than twelve to eighteen months.

Function depending upon the restoration of normal power is not so successfully met as that where a fair range of motion is needed without great power. For this reason the transfer of flexors of the forearm to the extensor group is much more successful than the reverse.

Loss of function of the hand is often complete, or nearly so, due to loss of balance, even though the paralysis is limited to a comparatively small group of muscles and the great bulk of muscles of the forearm remain active and capable of function. This is well exemplified in the case of irreparable injury of the musculo-spiral or posterior interosseous nerves, resulting in complete wrist and finger drop. The inability to extend the wrist, thumb, and fingers makes it practically impossible to use the flexors, which may be perfectly normal but out of use, due to the lack of balance.

The problem confronting the surgeon is to attempt a redistribution of the active muscles so as to balance the hand and permit of restoration of function of the intact muscles.

Certain principles must be adhered to, if satisfactory results are to be secured. That these principles are not fully understood, or at least are not acted upon, is obvious from the fact that recently several papers have appeared in the surgical literature, in which these principles are grossly violated and the results obtained cannot be as good as they otherwise might be. The procedure is thus condemned to carry a responsibility which should not be attached to it.

It is from a fairly large personal experience of several hundred cases, and from an opportunity of seeing the results of a great many others, that the writer ventures to lay down certain principles which are essential to complete success.

1. So far as possible, muscles having similar action to the ones they are to replace should be used. While it is perfectly true that a muscle, having a diametrically opposite action to the one it is to replace, may be transferred and trained to functionate automatically in its new capacity, yet it is obvious that a much shorter period of training will be necessary and a better ultimate function will be obtained, if one of similar action is transferred. For example, one of the extensors of the wrist, the extensor carpi radialis longior, may be transferred to the long extensor of the thumb and learn to perform the function of a thumb extensor in a very few weeks, whereas a flexor of the wrist so transferred, will require a long period of patient training.

2. If only a portion of a tendon is to be transferred *it must* have the same action as the muscle it is to replace. Using the preceding example it is perfectly feasible to transfer half of the tendon of the

extensor carpi radialis longior to the long extensor of the thumb and obtain good results. On the other hand it is hopeless to expect to transfer half of the flexor of the wrist, say the flexor carpi radialis to the extensor of the thumb and expect any results. That would be asking a muscle to perform two opposing actions at the same time, yet this very operation is described in a recent paper and good results are reported. An even more gross impossibility is reported in another paper where a section of the tendo Achillis is split from its outer side and carried forward to an insertion into the peroneus longus and a second section taken from the inner side similarly carried forward to the tibialis anticus, the remaining section remaining attached to its normal insertion into the os calcis. A stabilized or balanced foot is reported. This is obviously incorrect and serves no other purpose than to bring a good operation into disrepute by asking it to do the impossible.

3. The line of pull should be as straight as possible for mechanically the muscle will work more efficiently if the line between its origin and its *new* insertion is a straight line. This necessitates long incisions and care to see that the tendon, which winds obliquely around the arm, for instance, is not widely deviated by any hindering structures.

4. The fixation of the transferred muscle should be with a good deal of tension. This will take up any slack due to straightening out of the line of pull when such line has not been perfectly straight at time of operation. It also allows for a little slipping which often takes place at the point of fixation. The position of the member to be controlled therefrom should be one of considerable over-correction when the transfer is made.

Our lack of experience in earlier cases showed poorer results, due to neglect of this principle, than the later cases where it was carefully observed.

5. Any deformity due to contraction of tissues should be overcome before transfer of muscles is attempted. A group of cases has been seen by the writer, in which the best results were not obtained because of failure to secure the necessary correction of deformity before operation for tendon transference.

6. Tendons may be transferred to a new position by utilizing the sheath of the muscle to be replaced and threading the new tendon down the sheath, but for the most part transferred tendons should run in the fatty subcutaneous tissue.

7. In the lower extremity it is a common experience that tendons transferred should be inserted into bone or periosteum. In the upper extremity the attachment of tendon to tendon has been quite satisfactory.

8. Care should be taken to adequately fix tendon to tendon, as a good many cases have failed and required subsequent reoperation because the union has slipped. In our experience the recipient tendon should be slit, the transferred tendon denuded of its sheath by scraping thoroughly, and macerating somewhat, by Kocher forceps. This tendon is then threaded through the slit in the recipient tendon or tendons, sutured in two places and either buried in it or turned back and stitched to itself.

The suture material we have found most satisfactory is linen, and in no case have we had any infection which could be traced to this cause and in no case have the sutures been extruded.

Catgut will not stand the strain of attempted movement at the end of three weeks as seems essential to get best results.

9. The limb must be placed in a splint, preferably of plaster of Paris, and all motion, which would strain the suture linen, prevented for three weeks. Then a removable splint is substituted and removed daily for training.

The training should be in the hands of an expert who has a thorough knowledge of anatomy and who has seen the operation performed, so as to be able to appreciate the aims of the surgeon. At the end of two months all splints may be discarded.

By far the greatest number of cases of muscle transference in the army has been for irreparable injury of the musculo-spiral nerve. The best results have also been obtained in this injury, probably because this nerve is for the most part a purely motor nerve and the remaining disability from anæsthesia is negligible, and partly because the power required to overcome the disability is really only that necessary to overcome gravity. The technique of operation for this disability will serve as illustrative of all. The object of operation is to restore the extensor function of the thumb, wrist, and fingers.

The arm is prepared in the usual way and painted with iodine from above the elbow to the finger tips. The whole forearm is left exposed by the draping. An incision about five inches long is first made on the palmar aspect of the forearm between the tendons of the flexor carpi radialis and the palmaris longus ending at the wrist. The exposed tendons are carefully freed from their sheaths well up to the middle of the forearm. To avoid injury to the tendons they are

only handled at the points of their insertion. The tendons are then divided at their insertion and the skin edges clipped together. A long incision, seven or eight inches long, is made on the dorsal aspect of the forearm following a line from the external condyle of the humerus to the styloid process of the radius with the hand prone. The incision ends in a slight hook at its lower end to thoroughly expose the extensor tendons of the thumb. This incision is made through the skin and deep fascia, exposing the muscles. All hæmorrhage should be controlled by clipping superficial veins, and if this is thoroughly done no further bleeding of moment will be encountered. We believe better results are obtained if no tourniquet is used, and of course one eliminates the danger of temporary paralysis from pressure. If this incision is properly placed, it immediately overlies the septum between the radial extensors of the wrist and the extensor communis digitorum. With sponge pressure or blunt dissection the bellies of these muscles are separated down to the radius at the upper end of the incision. This exposes directly the oblique insertion of the pronator radii teres into the outer surface of the radius.

This insertion is completely freed with a periosteal elevator taking the periosteum with it. By blunt dissection it should be determined that this muscle insertion is absolutely free, otherwise it will not act freely in its new capacity.

The extensors carpi radialis longior and brevior are stabbed and the freed end of the pronator teres is threaded through from the deep surface and its periosteal ending sutured to the aponeurotic surface of these muscles. The tag ends should be buried by a Lembert type of suture so as to leave the surface smooth. The tendons of the common extensor to the fingers are freed from their sheath above the annular ligament and the separate sheath of the extensor minimi digiti opened so as to bring all four tendons together. The three extensors of the thumb are next exposed as they pass obliquely around the lower end of the radius. The long extensor of the thumb is lifted from its separate tunnel and brought alongside the extensor ossis metacarpi and the primary extensor of the thumb. Next, the fat of the subcutaneous tissue is tunnelled obliquely between the upper end of the palmar incision and the lower end of the dorsal incision, and the flexors are brought through this tunnel so as to give a straight pull. The three exposed extensors of the thumb are slit and the palmaris longus, after being denuded of sheath and all areolar tissue, is threaded through all three, and stitched to each in order, with sufficient tension to keep the thumb extended.

The four common extensor tendons are similarly slit and the prepared flexor carpi radialis threaded through, suturing securely when it passes through each slit. The end of the transferred tendon may be buried in the extensor minimi digiti or turned back on itself and stitched to each tendon in turn and then to itself. The fingers and wrist must be kept in position of hyperextension during this procedure. No attempt is made to suture the fascia on either surface of the arm, but an attempt is made to cover exposed sutures of tendons with the subcutaneous fat by bringing skin edges together with a subcutaneous suture. A plaster of Paris splint is put on over a sufficient dressing and left for three weeks.

In all, about three hundred cases have been operated upon by tendon transference, for various disabilities, in the Dominion Orthopædic Hospital, Toronto. The general impression formed as to results is that they are nearly perfect in the great majority of cases, and where the results are only fair it is usually due to the fact that limited movements of joints have not been entirely overcome, or that the tendon fixation has slipped. In other words, the failure to secure perfect result is, in nearly all instances, due to a fault which might have been overcome.

It has been difficult to get a final report in a great many of these cases, but the attached report shows end-results in 52 cases in which a recent examination was possible.

The results collected are seen to be after periods varying from three months to 2¾ years.

They are summarized as follows: Excellent, 29; good, 15; fair, 7; failure, 1. Total, 52.

In results classed as excellent the patients are able to perform any function which they could before the injury, with the exception of having somewhat lessened power.

In results classed as good, function is restored but movements are not quite as free as normal and power somewhat lessened.

In results classed fair, a great improvement is obtained, but motion is restricted and power limited.

Only one failure is noted, case of Lieut. F., and the report shows that a number of other factors enter into this result.

The metacarpo-phalangeal joint and all the tendons to the thumb were injured and an attempt was made to establish both flexion and extension.

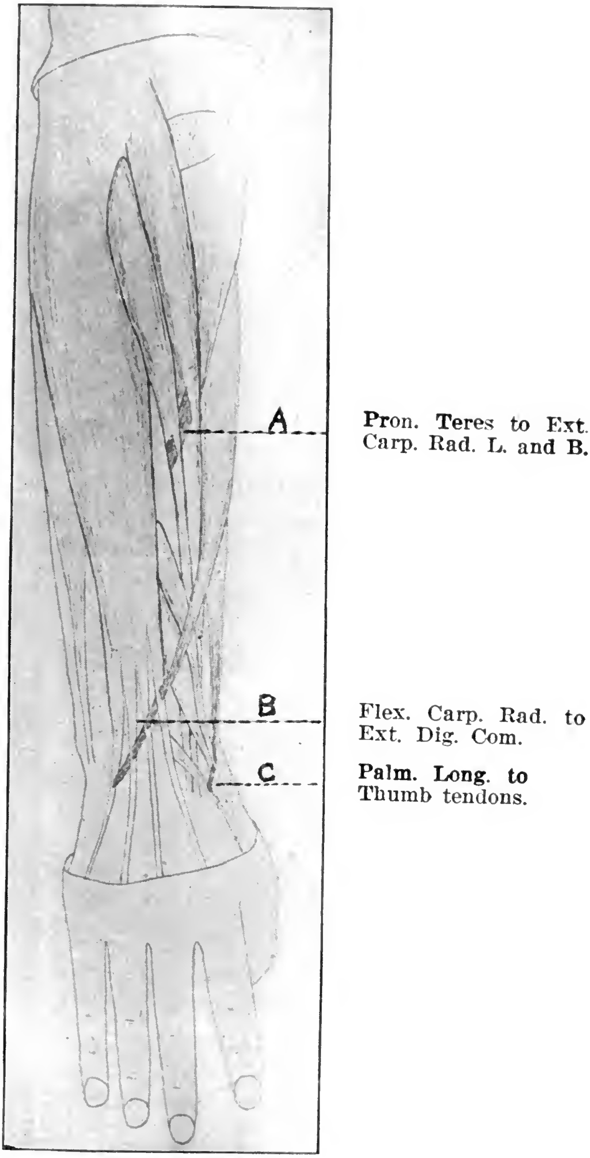

FIG. 1.—Diagram of the operation of tendon transference for irreparable musculospiral injuries.

SUMMARY OF THE RESULTS OBTAINED FROM OPERATIONS FOR TENDON TRANSFERENCES. DAVISVILLE AND D. O. H.—AUGUST, 1918, TO NOVEMBER, 1920.

NOTE.—Under "Type of Operation" the term "Complete transference" means a transfer as follows: Pronator Teres to Ext. Carp. Rad. L. & B.; Palm. Long. to Abduct. Poll. Long., Ext. Poll. Brev.; Flex. Carp. Rad. to Ext. Poll. Long., Ext. Dig. Com.

Number 91178: *Rank*—Gunner. *Type of Injury*—Irreparable musculo spiral lesion, Rt. *Type of Operation*—Complete transference. No Palm. Long., hence Flex. Carp. Rad. split. *End-Results*—2¾ years after operation, functional result excellent. Has worked as a carter since discharge without having to stop work. Anatomical result fair. Can extend hand from full flexion to 180°. Can fully extend fingers when wrist is at 180°. Can abduct thumb clear of wrist. Movements are free and strong. (See Fig. 2)

FIG. 2.—Case No. 91178.

Number 10916: *Rank*—Private. *Type of Injury*—Irreparable musculo spiral lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—2½ years after operation, functional result excellent. Uses hand for everything. Drives a car. States that function is perfect. Anatomically,—Can extend wrist from full flexion to 210°. Does not extend the fingers well. These remain flexed on hand at an angle of about 150°. Thumb just clears the carpus. Wrist-drop is permanently cured.

Number 663144: *Rank*—Private. *Type of Injury*—Irreparable musculo spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—2¾ years after operation. Functional result excellent. Uses arm for everything, including heavy work. Spent some time as a laborer grinding rail joints. Anatomically—Can extend wrist from full flexion to 210°. Can extend fingers separately from wrist. Thumb clears hand.

FIG. 3.—Case No. 291383.

Number 407716: *Rank*—Sergeant. *Type of Injury*—Irreparable M. S. lesion, Lt. Gas gangrene with extensive adhesions of tendons to sheaths. *Type of Operation*—Complete transference. *End-Results*—2½ years after operation. An astonishingly perfect result. Hand is quite as useful as before injury. Strength only is subnormal and that slightly. Can extend wrist from 150° to 210°. Can extend fingers fully with wrist at extreme of extension. Can abduct thumb well. It is hard to tell the hand from normal.

Number 745202: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion. *Type of Operation*—Complete transference. Palm. Long. absent. Flex. Carp. Rad. split. *End-Results*—Three months after operation. Fair result. Extends fingers to straight line. Abduct thumb well. Extends wrist 20°.

Number 192480: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—13 months after operation. Result is not very good. Operation was hampered by numerous and extensive limitations of movements of shoulder, elbow and wrist. Range of movement of wrist small. A. G. F., 155. A. G. E., 180. Thumb just clears hand. Marked limitations of movements of fingers.

Number 291383: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—3 months after operation. Excellent result. All movements of left hand normal in range but subnormal in strength. A. G. F., wrist, 145. A. G. E., 215°. Extends fingers well and abducts thumb. (See Fig. 3)

Number 445761: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—2 years after operation. Excellent functional result. Has worked continuously since discharge. Hospital orderly. Anatomically—Can extend wrist from full flexion to 180°. Cannot get beyond this. Fingers can be maintained in full extension when wrist is at 180°. Thumb is abducted well.

Number 709874: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. Palm. Long. absent. Hence Flex. Carp. Rad. split. Because of failure to develop extension of wrist, the wound was reopened in two months' time and the Pron. Teres found to be sutured to fascia and not to Ext. Carp. Rad. This was corrected with an excellent result. *End-Results*—2¼ years after operation. Excellent functional result, though anatomically it is only fair. Worked for some time as a moulder, but had to give this up because of weakness of forearm. Can do anything not demanding strength. Anatomically—Flexion full. Exten-

Fig. 4.—Case No. 174108.

sion to 170°. Fingers can be extended fully. Thumb is abducted clear of hand.

Number 174108: *Rank*—Private. *Type of Injury*—Irreparable post. interosseous lesion, Rt. *Type of Operation*—Modified transference. Carpal extensors fixed to radius and ulna by Kang. tend. Flex. Carp. Rad. L. to Ext. Dig. Com. and Ext. Poll. Long. Palm. Long. to Ext. Poll. Brev. Abduct. Poll. Long. *End-Results*—2 months after operation. Moderately successful. Wrist remains well extended and fixed. Extends fingers to 180°. Can use hand for all light occupations not demanding strength. (See Fig. 4)

Number 802878: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—6 weeks after operation. "Can partially extend fingers. Has nearly normal range of movement in thumb. Wrist is fixed in slight hyperextension with slight movement accompanied by radial deviation." A case discharged very early after operation.

Number 730023: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—2½ months after operation. Board states, "Has good dorsiflexion of wrist and extension of thumb and fingers. Only defect is in decrease in strength."

Number 772243: *Rank*—Private. *Type of Injury*—Irreparable post. interosseous lesion, Lt.; also irreparable ulnar lesion, Lt. *Type of Operation*—Complete transference, leaving wrist without any primary flexors. *End-Results*—1 year after operation. Excellent result, one of the best obtained. The hand is changed from one presenting complete musculo-spiral and ulnar paralysis to a complete ulnar lesion only. Wrist movement—A. G. F., 155. A. G. E., 215°. Can extend fingers to almost the straight line when wrist is fully extended. Extends thumb well.

Number 231468: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. Ischæmia. *Type of Operation*—Complete transference. *End-Results*—1 year after operation. Result poor. Has almost no power of extension of wrist, which is kept in a slightly dropped position. Apparently the poor result was due to widespread ischæmia affecting all muscles of forearm.

Number 513003: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—6 months after operation. Board states: "Flexion all fingers full. Extension all fingers, 180°. Thumb can be fully extended." No note on movement of wrist.

Number 193188: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—13 months after operation. Fair result. Extends wrist 35° (A. G. F., 190. A. G. E., 225). Extends fingers moderately well. Abducts thumb clear of flexing fingers. Function is impaired because of complicating fibroses of fingers and injury to humerus. (See Fig. 5)

Fig. 5.—Case No. 193188.

Number 955125: *Rank*—L./Cpl. *Type of Injury*—Irreparable musc. spir. lesion, Rt., combined with complete ulnar lesion and ankylosis of elbow and wrist. *Type of Operation*—Modified transfer because of ankylosed wrist. Flex. Carp. Rad. to Ext. Dig. Com. Palm. Long. to Ext. Poll. Long. *End-Results*—2 months after operation. Moderate range of movement of fingers. Perfect functional result is greatly hampered by extensive fibrosis and limitation of movements of joints.

Number ———: *Rank*—Major. *Type of Injury*—Irreparable musc. spiral lesion. *Type of Operation*—Complete transference. *End-Results*—2 years after operation. Excellent result. Wrist—A. G. F., 125; A. G. E., 205. Extends fingers normally. Abducts thumbs well. Can use well for all purposes not demanding strength. If he grasps very strongly the hand goes into flexion due to the stronger flexors. Apart from this the hand is perfect.

Number 475958: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—17 months after operation. Fair result. Range of movement of wrist about 35°. Extends fingers to 180°. Abducts thumb. Function is greatly impaired because of non-union of humerus.

Number 730649: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. Palm. Long. absent, hence Flex. Carp. Rad. was split. *End-Results*—5 months after operation. Moderately good. A. G. F., wrist, 160°. A. G. E., 210°. There is radial deviation on extension. Fingers—Extension normal, but flexion is limited, especially at metacarpo-phalan-

geal joints, so that fingers cannot touch palm. Power grip 50% normal.

Number 901431: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—4 months after operation. Board states, "Excellent result. Can extend fingers and thumb well. Dorsiflexion of wrist is good. Grip is 1/2 normal. Can use hand for all ordinary purposes although it is a little clumsy yet in finer movements."

Number 928504: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—4 months after operation. Board states: "Can dorsiflex wrist 20°. Extends fingers fairly well. Extends and abducts thumb well. Power is one-fifth normal. Cannot write because of weakness of power of extensors of wrist.

Number 712981: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—2 months after operation. Board states: "Can now extend fingers, extend and abduct thumb, and has slight power of dorsiflexion of wrist."

Number 858378: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—8 months after operation. Board states: "Can now extend wrist, thumb and fingers well."

Number 709762: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. Palm. Long. absent. Flex. Carp. Rad. split. *End-Results*—4 months after operation. Board states: "Movement of fingers good. Considerable limitation of wrist movement." (See Figs. 6 and 7)

FIG. 6.—Case No. 709762.

Number 2075444: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—7 months after operation. Board states: "There is now good dorsiflexion of wrist, good extension of fingers and abduction of thumb."

FIG. 7.—Case No. 709762.

Number 2256971: *Rank*—Private. *Type of Injury*—Irreparable musc. spiral lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—6 months after operation. Board states: "Can now extend fingers, extend wrist and extend and abduct thumb very well."

Number 748684: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—2 months after operation. Board states: "Excellent result. Patient can extend wrist, extend fingers, extend and abduct thumb very well. Power of the hand is much reduced. Grip is about one-fifth normal. Has very good use of hand for all ordinary light work." (See Fig. 8)

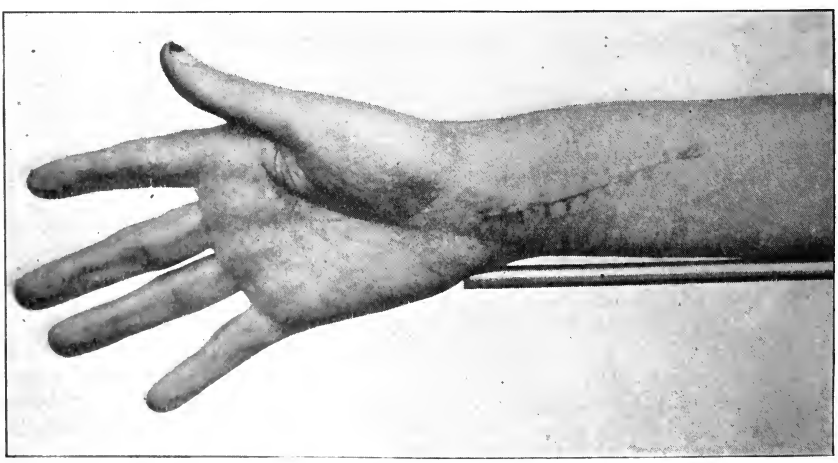

FIG. 8.—Case No. 748684.

Number 3106024. *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion. Rt. *Type of Operation*—Complete transference. *End-Results*—3 months after operation. Board states: "25° movement of wrist. Good extension of fingers and abduction of thumb. Function is impaired because limitation of flexion of fingers and reduced power of grasping."

Number 448710: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion. Rt. *Type of Operation*—Complete transference. *End-Results*—3 months after operation. Board states: "Range of movement of wrist 45°, distributed equally on either side of mid-position. Extension of fingers normal. Abduction of thumb 90% normal. Hand is weak." Prints, which are poor, are attached.

Number 3130147: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion. Rt. *Type of Operation*—Complete transference. Four months later, exploration of wound because of inability to extend wrist, revealed suture of Pron. Teres to Ext. Carp. Rad. L. & B. had slipped. This was resutured. *End-Results*—1 year after operation. Excellent result as far as fingers and thumbs are concerned. Wrist is not so good. Has about 35° of flexion.—Extension distributed either side of mid-position, rather more on the flexion side than on the extension.

Number 246767: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—8 months after operation. Excellent. Can extend wrist to 195° from almost full flexion. Extends fingers and extends and abducts thumb well. Can use hand for all ordinary light work. Its function approaches normal except in strength.

Number 733289: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—7 months after operation. Very good result. Extends hand, extends fingers and extends and abducts thumb well. Range movement, wrist, 60°. Uses hand for all light movements.

Number 26174. *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—7 months after operation. Fair result. Sixty degrees of movement at wrist. A. G. E., however, is only 180°. Power of extension of wrist is weak, so that he still drops wrist when grasping objects. Fingers extend well. Function is improved.

Number 444771; *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Rt. *Type of Operation*—Complete transference. *End-Results*—7 months after operation. Fair result. Wrist—A. G. F., 155; A. G. E., 205. Fingers can be extended to almost straight line. Thumb abducts clear of hand.

Number 103635: *Rank*—Private. *Type of Injury*—Complete section rt. post. interosseous. *Type of Operation*—Complete transference. *End-Results*—9 months after operation. Very good functional result. Wrist—A. G. F., 110°; A. G. E., 180°. Extension of fingers good. Abduction and extension of thumb excellent. Marked limitation of flexion of fingers at m.p. joint impair usefulness of hand.

Number 238098: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—5 months after operation. Fair result. Range of movement at wrist 35°. Excellent extension and abduction of thumb. Fair extension of fingers. Function is much impaired by multiple ankylosis and limitation of movement, due to other complicating G. S. W.

Number 672214: *Rank*—Private. *Type of Injury*—Irreparable musc. spir. lesion, Lt. *Type of Operation*—Complete transference. *End-Results*—7 months after operation. Good result. Can extend wrist fairly and can extend finger and thumb, and abduct thumb very well.

Number 634192: *Rank*—Private. *Type of Injury*—Flail elbow, with injury to post. interosseous N., Lt., resulting in loss of abduction and extension of thumb. *Type of Operation*—Flex. Carp. Rad. to thumb tendons. *End-Results*—Only fair. The transposed tendons contracted well but the looseness of the flail elbow resulted in the force being expended in pulling the forearm past the humerus instead of being exerted on the thumb.

Number 454818: *Rank*—Private. *Type of Injury*—Ankylosis of elbow and injury to post. interosseous N., Lt., resulting in loss of extension of fingers and thumb only. Extension of wrist retained. *Type of Operation*—Flex. Carp. Rad. to Ext. Dig. Com. and Ext. Poll. Long. Palm. Long. to Ext. Poll. Brev. and abduct Poll. Long. *End-Results*—4 months after operation. Moderately satisfactory. Can maintain full extension of fingers with wrist at 180°. If wrist is extended beyond this, fingers cannot be maintained in full extension. Greater mobility is hindered by widespread fibrosis of muscles, resulting from original injury and infection.

Number 472109: *Rank*—Private. *Type of Injury*—Partial section lt. musc. spir. N. Wrist extensors intact but paralysis of fingers and thumb extensors. *Type of Operation*—Flex. Carp. Rad. to Ext. Dig. Com. Palm. Long. to Ext. Poll. Long. and Brev., and abduct Poll. Long. *End-Results*—4 months after operation. Extends wrist to normal degree, but it is accompanied by radial deviation. Extends fingers to 180° when hand is at 180° to forearm. Can abduct thumb just clear of hand. (See print.)

Number 56028: *Rank*—Private. *Type of Injury*—Section rt. musc. spir. Nerve suture. Partial recovery. Residual paralysis of extensors of thumb and fingers. *Type of Operation*—Palm. Long. to abduct Poll. Long. and Ext. Poll. L. & B. Flex. Carp. Rad. to Ext. Dig. Com. *End-Results*—3 months after operation. Board states: "Can now extend fingers and thumb well."

Number 818178. *Rank*—Sig. *Type of Injury*—Partial section musc. spir. nerve, Rt. Residual paralysis of fingers and thumb. *Type of Operation*—Ext. Carp. Rad. Long. to Ext. Dig. Com. Flex. Carp. Rad. to thumb tendons. *End-Results*—3 months after operation. Board states: "Has now fair power of extension of wrist and

fingers. Extension and abduction of thumb good. Power is one-half normal."

Number 916918: *Rank*—Private. *Type of Injury*—Partial section musc. spir. nerve, Rt. Residual paralysis of fingers and thumb. *Type of Operation*—Flex. Carp. Rad. to thumb tendons. Fingers not touched. *End-Results*—6 months after operation. Board states: "Fair power of dorsiflexion of wrist. Extends fingers by means of interossei and lumbricals. Abducts and extends thumb well.

Number 901872: *Rank*—Private. *Type of Injury*—Destruction of extensor muscles, Lt., by G. S. W. Wrist-drop due to muscle damage. Radial extensors retained some power. *Type of Operation*—Flex. Carp. Rad. to Ext. Dig. Com. Palm. Long. to Ext. Poll. Long. *End-Results*—7 months after operation. Function is fair. Wrist—A. G. F., 180°; A. G. E., 220°. Can maintain fingers in full extension with hand fully extended. Can abduct thumb clear of the flexing fingers. Range of movement is small but useful. Strength is about one-eighth normal, due in part to muscle destruction. Can use hand for many movements not demanding strength or skill. (See Fig. 9)

Fig. 9.—Case No. 901872.

Number 775700; *Rank*—Private. *Type of Injury*—Partial section post. interosseous N., resulting in inability to abduct thumb. *Type of Operation*—Palm. Long. to thumb tendon. *End-Result*—8 months after operation. Fair abduction and extension of thumb. It just clears flexing fingers.

Number 690865: *Rank*—Private. *Type of Injury*—Section of flexor tendons, lt. index and middle fingers. *Type of Operation*—Abductor Poll. Long. into Flex. Dig. Sub. Flex. Carp. Uln. into Flex. Dig.

Prof. *End-Results*—18 months after operation. Excellent flexion of fingers. Before operation these were hyperextended at the interphalangeal joints by the unopposed action of the interossei and lumbricals. At time of discharge he could flex these through a range three-fourths normal.

Number ———: *Rank*—Lieut. F. *Type of Injury*—G. S. W. forearm, destroying thumb muscles. *Type of Operation*—(1) Ext. Dig. Com. to Ext. Poll. Long. Ext. Carp. Rad. to abduct Poll. Long. (2) 3 months later. Ext. Carp. Rad. Long. to all extensors of thumb and Flex. Carp. Rad. to Flex. Poll. Long. *End-Results*—4 months after last operation. Board states: "Patient has no control of thumb."

Number 877334: *Rank*—Corporal. *Type of Injury*—Low section median nerve with recovery of sensation but paralysis of opponens. *Type of Operation*—One-half of tendon of Flex. Poll. Long. transplanted into drill hole in head of thumb metacarpal. *End-Results*—1 year after operation. Fair result. Is able to bring the tip of the thumb almost in contact with tip of ring finger. It is not quite true opposition though the thumb is partly rotated. It resembles flexion plus adduction.

Number ———: *Rank*—Lieut D. *Type of Injury*—G. S. W. forearm, destroying extensors. *Type of Operation*—Flexor carpi radialis to common extensor. Palmaris Longus to thumb extensors. *End-Results*—2 years after operation. Result perfect.

DISCUSSION OF DR. STARR'S PAPER.

Sir Robert Jones, Liverpool: I am in agreement with nearly all that Dr. Starr has said and, as his paper covers a considerable range of surgery, I will confine my remarks to that portion of it dealing with musculo-spiral palsy in its connection with tendon transplantation. The operation had proved of great value in war surgery, and long before the war I had opportunities of practising it in civil surgery. Indeed, we are now able to state definitely that failures to obtain functional results were due to faults of technique or defective after-care. Indeed, I would go further and say the measure of success was in direct relationship with the knowledge and technical skill of the surgeon. It would seem too obvious to state that tendon transplantation should never be performed when there is a chance of nerve recovery were it not that in my military inspections I found many cases where not only did the muscles act but the nerve had also recovered its power. We made it a rule in those cases where we knew that the nerve had been well sutured and the after-care correct, to await for at least twelve months before considering the question of muscle transference. In cases where we had no knowledge of the operator, or the operation findings, an exploration was made without delay. This decision was more than justified by the extraordinary revelations that occurred. A tendon transplantation is always to be preferred to any operation of neuroplasty or nerve transplant.

There are certain fundamental principles to be adhered to, such as that the transplanted tendons should be kept in relaxation and traverse a straight line from origin to new insertion, that tendons should not pass through cicatricial tissue and should not be expected to mobilize a stiff joint. If the wrist is ankylosed and cannot be mobilized, it should be fixed in dorsiflexion. Similarly, the hand and fingers should be mobilized, where pos-

sible, before the tendon is transplanted. The transplanted muscle should be held in slight tension. Under excessive tension, muscle atrophies, while if the tendon is left too slack, restoration of its function will be long delayed. The tendons which I recommended should be utilized in pre-war days are those which I still think best. If the nerve is injured above the level of the origin of the post interosseus, the flexor carpi radialis should be inserted into the three extensors of the thumb and to the extensor of the index finger—the flexor carpi ulnaris into the extensor of the remaining three fingers. The pronator radialis teres is to be transplanted into the extensor carpi radialis longior, *et brevior*. The point I have always laid stress upon is cleanliness of dissection, and once the flexors have been brought to the back of the wrist, the joint should be kept in dorsiflexion from the time the operation is begun until recovery of the muscles has occurred. I have so often described the after-care that I will not take up your time further. Recovery is usually complete in from eight to ten weeks. A recovery is only considered good when the wrist, thumb, and fingers can all be fully extended.

Dr. W. G. Turner, Montreal: Mr. President, I should like to bear testimony to the work that Dr. Starr has accomplished. We were very fortunate, Sir, in having the example of various centers throughout Great Britain. This system was organized early in the war and carried on, not only in Great Britain but also in Canada; and it certainly was a great factor in bringing treatment to a high standard. The advantage has been that we have had fundamental principles laid down and well followed. We must all realize that Sir Robert Jones accomplished this wonderful organization. As far as my country is concerned, I feel grateful to the organization that Colonel Starr brought into existence. It was due to that, that we avoided mistakes in this country; and the after-treatment of these cases was conducted very carefully.

Dr. Clarence Starr, Toronto: I want to thank Sir Robert Jones for his kind remarks, and to acknowledge my indebtedness to him and his confrères for the stimulus they gave to the work. I have been wonderfully helped by their suggestions. We are not all quite as competent as Sir Robert Jones. My experience, after doing a large number of cases, is that I can get them more room and more definite alignment from a large incision than from multiple small incisions. The fault is to be found that Sir Robert Jones emphasized the fact that the men did not at first learn the principles, and then did not stick to them. It seems so obvious, yet as he has pointed out, you will see cases in which these principles are so grossly violated that it is patent at once that it was an impossibility for the patient to have recovered function.

AMYATONIA CONGENITA: REPORT OF A CASE.

BY CHARLES A. STONE, ST. LOUIS, MO.

From the Department of Orthopædic Surgery, Washington University Medical Department.

It is not the intent of this paper to go into a long and exhaustive discourse of the condition on which Oppenheim[1] published his obser-

vations in 1900. Much has been written about what he called Myatonie, but cases are yet uncommon enough to justify description and comment upon a new one.

Ten years after the publication of the notes on this little understood condition, Habermann[2] states that he could find no mention of it in any text-book on either neurology, pediatries, or internal medicine. In an article by Foot[3] in May, 1913, he mentions the fact that 75 cases had been reported, 13 accompanied by autopsy findings. During March, 1920, P. Haushalter[4] says there had been a total of 155 cases reported, including three of his own, showing that during the seven years from 1913 to 1920 more cases had been seen than during the preceding thirteen years.

Oppenheim in his first article thought that the pathological condition was to be found in the muscles which were retarded in development. But further on he also says that it is possible there may be a developmental error in the anterior horn cells. He adds that, though the condition resembles poliomyelitis anterior, it is not the same and has nothing to do with it.

As if to prove the contention that the muscles were in error, in 1905 at autopsy in a well-marked case of twenty-two months, Spiller[5] found a condition of decided regression in the muscles affected, but no changes were present in the nervous system. However, there have since been a number of histological examinations of both muscle and nervous tissue showing the same condition noted by Spiller, and in addition thereto, changes in the anterior horn cells. Later, Spiller and Griffith[6] report finding these same cells decreased in number and in size.

DEFINITION.

Faber[7] has given a very concise one, namely, a disease found at birth and due to a developmental defect of the lower motor neuron and of the voluntary muscles, clinically characterized by weakness, hypotonia and quantitatively diminished electrical responses, usually without disturbance in sensation or mentality.

ETIOLOGY.

Thus far, no causative agent has been found. Syphilis, tuberculosis, and other infections play no rôle.

The pathological findings lead to the conclusion that it is due to a congenital defect. In only a few cases have there been any others of the family or relatives affected. Where there is a record made

of the fact, more than half of the cases show that foetal movements were absent, weak or retarded. Nearly all of the pregnancies have gone to term without mishap and with normal deliveries, showing that accidents of gestation are not a factor.

A review of practically all reported cases since 1900 leaves the impression that we are as far from a solution as at first.

Foot believes that we are dealing with the evidence of some past disease manifested by the reparative reaction of the body.

The percentage of males affected is slightly higher than females.

RESEARCH.

Ziegler[8] and Pearce[8] have done the latest work on metabolism, confirming the conclusions of Spriggs[9], and of Gittings and Pemberton[10], that the creatinin excretion is greatly diminished. They also found excretion of creatin on a low protein diet; normal uric acid excretion; increased rest nitrogen accompanied by increased neutral sulphur; normal phosphorus excretion, therefore no bone disintegration, and lowered chlorid excretion.

AGE.

In over 80 % of the cases the onset has been noticed at or soon after birth. Some cases are noted as having come on at a later age, but from the evidence found in the pathological examination there may have been a question of the keenness of observation as to the exact time at which paralysis occurred.

PROGNOSIS.

A certain number of cases have shown improvement, but, considering the lack of development in the motor areas of the cord, it is hard to see how there can be much increase in muscle power. That which does occur is probably qualitative rather than quantitative. The death rate is high; about 90% from pneumonia.

TREATMENT.

Medicinal treatment has been of no avail, a number of different remedies having been tried. The most likely course of treatment is teaching the child to develop the muscle power already present.

DIAGNOSIS.

This is made upon finding at birth a flaccid paralysis, with few or no signs of atrophy. It is distinguished from the myopathies by not

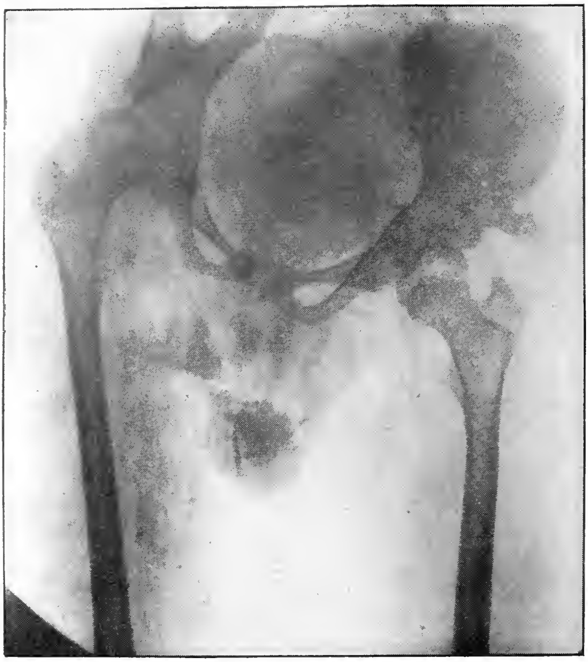

Fig. 1.—Shows the permanently tilted and deformed pelvis, with signs of bone atrophy in each femur.

being progressive, and from poliomyelitis by the muscle group characteristic of the latter, accompanied by marked atrophy of the muscles involved. It is possible that a general weakness found in rickets may at times be mistaken for myatonia.

CASE REPORT.

R. K. Age 12½. 1917. Admitted to Children's Hospital, February 8, 1917.

Chief complaint: curvature of spine; paralysis of legs. Father's age at patient's birth, 25; mother's age 24; two younger children, well and strong. One miscarriage. No history of any other paralysis in the family, except a brother of the mother, who had a paralyzed right arm following a disease of childhood—probably poliomyelitis. No history of tuberculosis, cancer, or nervous diseases in the family.

P. H. Has had chicken pox, measles and whooping cough; never had mumps, scarlet fever nor diphtheria. No exposure to any infectious diseases. General health good.

FIG. 2.—Typical bone atrophy of each femur is apparent. The contour of the thigh muscles can also be seen.

PRESENT ILLNESS.

Child was delivered feet first, the right foot presenting first, considerable difficulty being experienced by the doctor in making the delivery.

The mother states that during pregnancy foetal movements were not as vigorous as in other pregnancies. She fell three times during this period. The child's aunt, who cared for him until he was two months old, says he did not kick his legs from the beginning. This statement was made to the mother when she began bathing him at the end of this period and noticed that he did not kick. A doctor was called and pronounced it infantile paralysis. He has always had feeling in his legs. There was incontinence of urine and feces until four years ago, when he began to gain control of his bowels.

FIG. 3.—Is a lateral view of the sacrum and the spine above it.

After several years he got so he could move his legs a little and has improved greatly in his ability to sit alone.

Curvature of the spine was not noticed until the baby began to sit up; maybe not then, as he was two or three years old before the mother noticed it at all. It has only been so noticeable within the past few years.

The child never crawled on hands and knees, but pushed himself backward on his stomach by using his elbows. Later he moved about by sitting up and pushing along with his hands. At present he walks by bending over and grasping a foot in each hand, lifting one foot forward after the other. Can climb trees as well as any of the children. Got some frost bites on the calves of his legs three years ago. From the knees down his legs are always bluish-red and cold. He is very constipated.

Mother says she has had all kinds of doctors to see the child—even the osteopaths. An x-ray of spine when child was one year old revealed no abnormal findings.

PHYSICAL EXAMINATION.

Patient is a white male, 12½ years old. Lies quietly on his back and does not seem to be in any pain. Is pale and thin. Skin is warm, soft, smooth and elastic.

Head—The line of suture between frontal and parietal can be felt. No cranial tenderness.

Eyes—React to light and accommodation. Ocular movements normal. No abnormal pigmentation on sclera.

Ears—No tophi, tenderness, discharge, or deafness.

Nose—No obstruction.

Mouth—Teeth irregular. Tongue protrudes in mid-line. Tonsils slightly enlarged and reddened. Pharynx slightly injected.

Neck—Thyroid not enlarged. Palpable post-cervical glands on right. No abnormal pulsations.

Chest—Very irregular. Pigeon breasted. Distinct lagging of left side of chest on respiration. Heart not enlarged. Apex seems to be displaced to right. P. M. I. just to right of mid-line. No thrills, shocks or murmurs.

Lungs—P. N. hyper-resonant in right upper. Resonant throughout B. S. vesicular. No râles or friction rubs.

Liver—Dulness rises up to nipple line. Lower border of liver is above costal margin.

Back—Marked scoliosis. Some lordosis in lumbar region. No tenderness along spinal column.

Abdomen—Irregular. Slightly distended. No spasm or rigidity. A movable mass can be felt near the right kidney region. On deep palpation spine can be felt. There is a hand-length tender mass about 6x4 cm. just above the symphysis.

Pelvis—Is markedly tilted to right.

Genitalia—Scrotum small. Both testicles descended. There is incontinence of urine with some resulting irritation of skin surrounding parts.

Extremities—Upper are normal; reflexes present and equal. Lower are in a state of flaccid paralysis. K. K. and plantar reflexes can not be obtained. Cannot use any of the muscles of lower limbs. Toe-nails are small and irregular. Patient complains of coldness in lower extremities, and left foot was cold at time of examination. Patient has sensation in his lower extremities.

2-8-17—Hemoglobin—70%. W. B. C.—9,100.

2-15-17—Orthopædic consultation—no reflexes, extreme scoliosis—loss of bladder and rectum control. Good power in arms. Mentality above normal. Initiative above normal. Very little power in legs. Sensation normal.

Diagnosis—Extreme poliomyelitis.

Flaccidity with preservation of sensation, against upper neurone and pyramidal tract lesion. If in lower neurone must be purely motor.

Discount history because of good mentality with extreme paralysis.

Has dislocated but easily reducible left hip.

Recommend extensive braces to get patient upright.

3-7-17—Patient has considerable rise in temperature. Complains of very sore throat. Examination shows tonsils considerably swollen. Some flecks of membrane on tonsils. Culture taken. Isolated.

3-8-17—Culture negative for K. L. W. B. C.—15,000.

3-10-17—Condition much better. Temperature fairly normal. Tonsils still somewhat swollen. Patient says he has tonsillitis every winter. Would seem that a tonsillectomy were indicated.

3-20-17—Blood coagulation time taken yesterday—greatly delayed. Contracture tensor fascia femoris each side. Double Soutter advised.

3-22-17—Urine St. yellow, cloudy, acidity 0.20, white deposit, acetone negative, many leukocytes. Hemoglobin—70%.

Operation—Fasciotomy (Soutter's) 3-22-17.

Ether anesthesia.

Four-inch longitudinal incision between anterior superior spine and great trochanter on left side, exposing fascia lata. Anterior superior spine cut free, muscle elevated from inner and outer aspects of ilium. and spine allowed to slip downward toward the inferior spine, which was permitted after a transverse section of the ilio-tibial band and the very pale tensor fascia femoris.

Similar operation on right side. Long double spica from nipple down, with hips abducted and hyper-extended.

POST-OPERATIVE NOTES.

3-23-17—Complaining quite a little of cast. Temperature and pulse normal.

3-26-17—Temperature 103 this morning. Front of cast removed. Wounds in very good condition. Small pressure spot on right knee and chest.

3-27-17—W. B. C.—14,600: R. B. C.—4,736,000: Hemoglobin—65%.

3-30-17—Sutures removed; wounds have healed nicely. Temperature still elevated.

4-2-17—Temperature still elevated; 101; no cause found.

4-4-17—Temperature 99—comfortable.

4-11-17—Braces applied. Up in chair—temperature 99.5.

4-15-17—Discharged.

Diagnosis—Poliomyelitis.

5-14-20—Readmitted. Age 15 years.

Returned for new braces, having outgrown old ones.

The physical examination was the same as in 1917, except for the following notes:

Genitals—Fairly well developed. Has incontinence of urine, wearing rubber urinal. Fair growth pubic hair.

Arms and shoulders markedly well developed.

Spine—High right dorsal, lower left dorsal and lumbar scoliosis.

Fig. 4.—Is a lateral view showing typical bone atrophy in each leg, and the outlines of the calf muscles.

Pigeon breasted. Respirations equal and regular.

Lower extremities—Almost totally flaccid, the only power present being slight adduction on each side. Legs are short, adipose, soft and flabby, but without signs of definite atrophy. The toes are deformed and irregularly placed in extension. The plantar surfaces of the feet resemble large pads full of wrinkles, the middle is bulging and more prominent than either side, thus obliterating any evidence of a normal arch.

Fig. 5.—Is a antero-posterior view showing the same conditions as Figure 4.

Hypermotility of the feet in both extension and flexion. The dorsum of the foot may be placed on the anterior surface of the leg. Both knees may be greatly hyper-extended and there is permitted much lateral motion. Both feet can be put behind the head at the same time. The left knee can be placed behind the left shoulder. The right knee not quite so far. Each thigh can be placed alongside the body. Bending forward he can place his head between his legs. There is a scar on each thigh, extending from anterior superior spine to the great trochanter. This from the operation done in 1917.

Measurements taken are as follows:
Umbilicus to bottom of feet—71 cm.
Umbilicus to top of head—48 cm.
Circumference right calf—26 cm.; right thigh—31.5 cm.
Circumference left calf—25 cm.; left thigh—30 cm.
Circumference of pelvis—53 cm.
R. B. C.—4,792,000; W. B. C.—8,200.

5-18-20—Light cast of body as model for leather jacket. Measured for braces. Stiff ankle; drop catch at knees and hip; leg braces to be attached to jacket. Crutches.

5-19-20—X-ray. Lateral stereo lower dorsal and lumbar spine shows marked scoliosis, the nature of which cannot be determined.

5-21-20—Neurological consultation: Absence of any sensory findings suggests either an acquired process in the anterior horn cells of the sacral or lumbar segments or of a developmental defect in the cell region.

5-24-20—Antero-posterior and lateral views of both legs show an extreme grade of bone atrophy.

Later—A No. 10-F catheter introduced. Pin point meatus stretched, over 300 cc. residual urine obtained, loaded with pus, thick and creamy. Acid reaction. Retained catheter. Put on soda bicarb.

6-14-20—Wassermann neg. to:
Luetin Antigen.
Cholesterin Antigen.
T. B. C. Antigen.

6-15-20—Bladder irrigated, 10 cc. 20% argyrol instilled. Temperature down since bladder condition has been treated.

6-25-20—Temperature up to 103. Retention catheter replaced. 150 cc. turbid urine. Examination otherwise rather negative.

6-26-20—Temperature 100 this A.M. Feels good.

Braces applied. To be up and discharged.

DISCHARGE NOTE.

Able to get about by the aid of crutches. Given urotropin to take at home for five days. Diagnosis: amyatonia congenita.

ELECTRICAL EXAMINATION.

No nerve muscle or muscle response up to 110 volts in either leg, except the quadriceps and sartorius right, in which the chronaxie was .00015 sec. (normal) and vastus externus right, chronaxie .0008 sec., or very poor nerve supply; abdominal muscles and those of arm have good reaction at normal chronaxie. No anesthesia of legs, and slight voluntary movement of quadriceps. Slight flexion of thigh. No trophic changes in legs; impression, complete degeneration of motor nerves and muscles both legs except quadriceps sartorius right, which nerves and muscles are in fair condition.

Physical—Same as previously, except—

Genitalia—Large amount pubic hair. Penis and testes developed out of proportion to rest of body. X-ray 3-28-21. X-ray each leg shows extreme grade bone atrophy. Outlines of rather thin muscles are observed.

COMMENT.

We have, then, a boy born with a flaccid paralysis, which has shown but slight improvement. The increase in muscular power is probably due to greater strength in the muscles already present at the time of birth. There is little sign of atrophy, except that the thighs are small in comparison with the legs.

This patient has blueness, coldness, and tendency to chilblains, which are very infrequent. Contractures have been reported in a fairly large percentage of the cases, but are found mostly in the older ones, probably due to posture.

I have been able to find no case where there was involvement of the sphincters, but feel that this should not exclude the diagnosis in this instance. The neurological consultation, while not agreeing with the diagnosis, nevertheless says "this appears to be a congenital defect in the anterior horn cells," thus agreeing with what is given by many as an essential pathological finding in amyatonia congenita.

An injury at birth must be considered, since the record shows the baby came as a breech presentation and considerable force was used in making the delivery. However, if there had been an injury to the cord, some trophic disturbances must certainly have followed along with the sensory findings. This has not been the case.

A congenital myxœdema is excluded by a look at the patient's head and face, which have none of the characteristics found in this disease.

It does not belong to the myopathies, since there has been no localized wasting and no spreading from muscle to muscle and to regions not originally affected.

Consent for a biopsy was obtained, but the parents granted it, saying they were willing if it would do any good. This assurance could not be given and the diagnosis appearing so evident, the specimen was not obtained.

There has been only one older case recorded, that being 50 years of age. Two of 12 years are the next in order, excepting this boy. He is now in good health, with little prospect of a necropsy.

Measurements of a number of other boys were made to see how this boy compared. While his total height is very much less, the ratio of trunk to lower extremities was almost exactly the same as in normal boys the same age.

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TREATMENT OF TUBERCULOSIS OF THE ANKLE IN THE ADULT.

BY JACQUES CALVÉ, BERCK-PLAGE, FRANCE.

In considering the treatment of tuberculosis of the ankle-joint in the adult, several questions deserve special attention. Among these are:

1. What is the prognosis with the conservative treatment?
2. What is the duration of conservative treatment in those terminating favorably, or better still, after what period may we expect to return the patient to work?
3. How long should conservative treatment be tried before resorting to operative measures?
4. In what per cent. is amputation finally necessary?

In going over the literature it will be found very difficult to get information on these particular points. To state that a patient left the hospital with wounds healed, or that the patient made a good ultimate recovery, is not sufficiently to the point. The time element is a very important factor, and should receive special consideration. Strictly speaking, the title of this paper should limit consideration to the ankle-joint proper, that is, the astragalo-tibial articulation, but for practical reasons it may be well to include tarsal disease, since the tarsal bones are often involved secondarily.

Tuberculosis of the ankle is said to occupy third place in order of frequency of joints involved in the lower extremity. The bones bearing most weight are especially disposed to invasion. The astragalus,

tibia, and os calcis, therefore, are more frequently affected than the smaller tarsal bones. The astragalus is the most frequently involved.

While writers are not entirely in accord as to the seat of the primary involvement, the idea seems to be gaining ground that the primary seat is more frequently in the synovial membranes than in the bone. In the synovial type, the disease spreads more rapidly over the surface of the bone. In osteal lesions the disease process extends along beneath the cartilage, so that at operation the cartilage is frequently lifted off readily in large pieces. This undermining of the cartilage accounts for the fact that when healing follows the conservative treatment, a slight degree of motion usually persists, because of the remnant of cartilage interposed between the joint surfaces. The joint with a slight degree of motion is particularly disposed to lighting up of the latent infection, so that in cases where only a slight and not really serviceable degree of motion persists, firm bony ankylosis would be preferable. In astragalo-tibial disease, swelling is usually first noticed on the front of the ankle on either side of and along the extensor tendons, because the capsule is thinnest at this point. Fluctuation is most easily elicited during tarsal flexion of the joint. Later, effusion appears also below the malleoli. Extension of the disease to the os calcis and scaphoid is frequent. In walking, there is a tendency to equino-valgus with rotation outward of the leg and foot, the latter thus taking a more passive part in progression.

This position avoids motion at the astragalo-tibial and astragalo-scaphoid joints.

In the later stages, infiltration of the tissues and elevation of temperature are the rule. In subastragalar disease, the swelling is usually noted lower down. The characteristic signs and symptoms of tuberculosis of the ankle and tarsus are so well described in modern textbooks that repetition is unnecessary here.

In going over the figures of various authors writing on tuberculosis of the ankle-joint, it has been found that, with a few exceptions, cases of adult and childhood disease are grouped together. In view of the fact that both treatment and prognosis vary so markedly, it is deemed wise always to distinguish the two groups in offering statistics.

A review of the literature shows that the prognosis in children is very favorable and more so with conservative treatment than with operation. In childhood, conservative treatment should be carried out rigidly and consistently, paying attention to usual hygienic measures, including heliotherapy, as well as to local fixation. Occasionally minor operations, such as laying open of sinuses or excavation of an isolated

focus in a single bone, may be justifiable, but radical operations, removal of entire tarsal bones or excision of joints will rarely be called for. Humphries and Durham reported twenty-nine traced cases, average age of admission, 5½ years; average duration of treatment, 4 $^1/_6$ years. Of these 29 cases, 23 were cured. Of these 23, 15 had normal function and eight various degrees of limitation of motion and deformity. Six cases died.

Gibney reported three cases with "good, practically normal or normal function" in 24, ankylosis in six. Average duration of treatment, 3¼ years. In both of these series practically all of the cases were in children.

Ohse reported on a series of 115 cases of tuberculosis of the ankle at the Strassburg clinic, between the years 1894 and 1906; almost one-half of these were in children under 15 years. In his series, 26 per cent. came to secondary amputation; 19 per cent. of the resected cases died shortly after operation from other forms of tuberculosis. About 50 per cent. of the cases showed good anatomical results, the others showing various degrees of deformity and shortening from nothing to 11 cm.

Maass reported 167 cases from the Gottinger clinic. Of 39 cases treated conservatively, 29 came to operation later. He concludes that conservative treatment is contraindicated in all cases where x-ray shows foci in bone. This view does not find acceptance so far as it applies to children. These figures bring one point out strongly, and that is, that operations in children are contraindicated; also that if operative procedures in adults are carried out they should not be too long delayed.

Sever's series of 213 cases of tuberculosis of the ankle and tarsus includes only children. A comparison of results obtained by conservative and operative means leads him to urge avoidance of all radical operations on bones and joints of children except when all else fails.

Most valuable statistics are those of M. H. Rogers, though they cover a comparatively small number of cases. He traced 17 cases out of a total of 27 of tuberculosis of the ankle in adults treated at the Massachusetts General Hospital. This is the only series found in which adults only are considered. Fixation gave good results in only three cases, and duration of treatment was four years. Of the operative cases, resection was done in nine, and amputation in eight. Rogers advises early resection or amputation to save time, believing that the duration of treatment be cut down to not exceeding two years, if possible. Considering these statistics as a whole, they are far from

encouraging, and suggest that radical measures were often too long delayed. The writers believe that when the diagnosis of tuberculosis of the ankle-joint is certain, and the roentgenogram shows definite bony involvement of the astragalus, or of both astragalus and tibia, in a wage-earner, our attitude should be much the same as it is in tuberculosis of the knee. Few surgeons will now hesitate to recommend early resection of the knee. The statistics just quoted show clearly enough that conservative treatment, even if successful, requires too long a healing period. Also, that amputations are far too frequent to justify delay in resorting to radical measures in the type of cases cited.

Spengler, following a series of cases from Kocher's clinic, found that 40 per cent. of the patients suffering from ankle tuberculosis had died of some form of tuberculosis within a ten-year period. The restriction of normal activity incidental to ankle disease, conservatively treated over long periods, must be admitted as an important factor in predisposing to pulmonary and other tuberculous lesions. In persons other than laborers, with definite tuberculous involvement of ankle-joint and component bones, conservative treatment is fully justified and may be indicated for a period of perhaps six months. This will be sufficient to give one some idea as to the virulence of infection and resistance of the individual. If during this time there is no decided improvement, disappearance in whole or at least in large part of the swelling, pain and infiltration of soft parts, much time will be gained by radical operative measures.

A good general plan for conservative treatment modified to suit the individual case would involve, in acute cases, rest in bed for two weeks, with elevation of the foot, elastic compression bandage over lamb's wool, followed by plaster cast from just below the knee to toes. If the cast is well hollowed about the knee, it is not necessary to go above the knee. Beginning deformity can be corrected easily in this early period by gentle molding of the foot and retention in the corrected position by a succession of casts. Weight-bearing should be avoided by use of crutches and elevation of opposite shoe. Later, a Thomas splint, also preventing weight-bearing, may be substituted. If in six months there is decided improvement, a double-bar splint extending from below the knee into the shoe, with melted leather ankle support and foot plate, can be substituted in the later stages. General constitutional measures, exercises not involving the joint, and heliotherapy, of course, are presupposed here as in treatment of all joint tuberculosis. The Bier treatment has not been used because it cannot be em-

ployed at the same time maintaining consistent fixation. Attention to proper shoeing, especially to support of the arch, is advisable.

As in operative treatment of tuberculosis of the knee, the important point is to eliminate motion. This is, perhaps, not as easily obtained in the ankle as it is in the knee because it is more difficult to obtain firm and continuous bony contact. In the knee the broad femoral and tibial surfaces are more readily held by long spikes or other means of fixation.

Of the thirty different approaches to the ankle-joint referred to by Koenig, the Kocher method appears to be the most generally applicable and has been the method employed in the cases to be reported.

TECHNIQUE OF OPERATION.

Vertical incision from a point just behind the fibula and about two inches above the external malleolus downward, curving forward below the tip of the malleolus and extending forward on dorsum to lateral border of head of astragalus, division of peroneal tendons low down below external malleolus; division of external lateral ligament of the ankle, also of posterior and anterior portions of capsule as far as necessary in order to dislocate the foot completely inward so that the sole of the foot looks directly upward. This gives an excellent exposure of the interior of the joint, enabling careful inspection and removal of diseased synovial membrane as well as of articulating surfaces of tibia, fibula, and astragalus. This entire articulating cartilage is removed without, however, sacrificing any more healthy bone than is necessary. Care is taken to eradicate any diseased tissue between the tibia and fibula. The denuded astragalus is shaped so as to fit accurately into the fork of the tibia and fibula. In one case of another type, not included in the present series, the fibula had to be fractured and the malleolus displaced inward in order to secure proper contact. A very slight degree of equinus to allow for the usual height of the heel of the shoe is advisable. The foot should be in mid-position between valgus and varus. When the astragalus cannot be saved, a tibia-calcaneal arthrodesis is performed by removal of cartilage on superior portion of os calcis and lower portion of tibia. In this case, it is well to set the foot backward on the tibia in order to avoid the unwieldiness of the foot, just as in the Whitman astragalectomy for calcaneo-valgus following infantile paralysis. In one of the modern textbooks it is stated that in case the disease is confined to the ankle-joint, astragalectomy may assure removal of the disease, with retention of

motion. This advice runs counter to the generally accepted principle that elimination of motion is essential in controlling the disease. Ely believes it is the conversion of lymphoid marrow into fatty marrow which is responsible for the cure. This belief is erroneous because these ankle cases get well when motion is eliminated, in spite of the fact that the marrow does not change from lymphoid to fatty. So far as I know, there are no autopsy records available showing that even in the ankylosed knee-joint the lymphoid marrow gives way to fatty marrow. In the cases reported no special means of fixation were used outside of a snugly fitting plaster cast. Stiles uses a long, square nail introduced through the plantar surface of the heel through the os calcis, astragalus, and tibia. He removes the nail in three weeks, when a plaster cast is applied. If the disease is confined to the astragalus and if it cannot be saved with safety without extension to the joints, it may be removed and the foot displaced backwards.

In Stiles' series of fifteen traced cases, mixed adult and children, there were two in which ankylosis was not complete, slight flexion and extension being permitted. In one there was a discharging sinus. In every case the patient walked well without support.

In dealing with tuberculosis of the smaller tarsal bones, there is no reason why the principle of arthrodesis should not be carried out in a considerable portion of the cases. Certainly in astragalo-tibial and calcaneo-cuboid disease there should be no difficulty. When the cuneiform bones are involved it is likely that considerable sacrifice of bone will prevent firm bony contact of the walls bounding the resulting cavity, in which case removal of the entire bone may be necessary.

All curetting operations should be condemned because one cannot see what is being done; healthy bone upon which we must depend for firm bony ankylosis is likely to be removed, and diseased bone and cartilage are left behind, also uninvolved synovial sacs may be entered. Primary closure of the wound is indicated wherever possible. In case of sinuses drainage of superficial tissues is necessary. After-treatment should be conducted just as in non-operative cases. If the disease is very extensive and not likely to be controlled by methods above outlined, amputation should be performed. Statistics quoted here indicate that it would have been a time-saving and often a life-saving measure in many of the cases terminating unfavorably.

The cases forming the basis of this report are arranged in tabular form and require no especial comment. In conclusion, the following statements are offered as answers to the questions proposed in the

beginning of this article, attention, however, being called to the fact that disease in adults only is considered.

The prognosis of tuberculosis of the ankle in the adult with conservative treatment is poor. In the present series no case of astragalo-tibial disease was treated conservatively, the only non-operative case reported being one of subastragalar disease.

The duration of conservative treatment in the cases terminating favorably, according to the only statistics referring to adults, is four years.

A six months' period of conservative treatment will probably be sufficient to determine efficacy of this form of treatment.

Statistics referred to show that amputation is far too frequent because conservative measures are persisted in for too long a period, also that in the cases followed over a ten-year period, nearly 50 per cent. died of other forms of tuberculosis. In further reports of cases, separation of cases into adult and childhood groups is urged.

THE TREATMENT OF PARALYTIC FLAT FEET.

BY LEO MAYER, M.D., NEW YORK CITY.

In the treatment of paralytic flat feet, exact recognition of the grade of the deformity is as important as the operative technique employed in its correction. It is, therefore, well to attempt to classify paralytic flat feet into a number of different types, depending upon which muscles are weakened and the extent to which they are paralyzed.

Type I.

In this, the tibialis anticus is the only muscle paralyzed. All the other invertors of the foot function normally. Consequently, with the foot below a right angle, inversion is possible, but when the foot is held dorsiflexed, little or no inversion can be performed. In treating this type of case it is always advisable to make a preliminary test to decide the degree of paralysis of the tibialis anticus since very frequently some of the muscle fibres are still intact and require only suitable chance to regain their normal length before their function can be made to return. This test consists in immobilizing the foot in such a position

as to bring the origin and insertion of the tibialis anticus as near together as possible—in other words, in calcaneo-varus. If the Achilles tendon is shortened and offers any resistance, it should be divided subcutaneously. The foot should be held in this position of calcaneo-varus for five or six weeks. If by that time there is no return of function in the tibialis anticus, its paralysis may be safely assumed to be complete. In that event, the treatment would be the same as that employed in certain cases of the second type. If, however, as frequently occurs, the muscle shows a spark of contractile power, the postural treatment should be continued and every attempt made to further strengthen the returning life of the muscle by exercises, massage, and all other means of increasing its nutrition. In this preliminary test of the muscle, I have found plaster of Paris most suitable for the purpose. When the muscle is beginning to function after the six weeks' test, I use a brace, holding the foot in the same position and allowing the patient, at the same time, to walk about.

Type II.

This second group of cases includes those of the first, in which the tibialis anticus has shown itself to be conpletely paralyzed, and those in which, with a partial paralysis of the tibialis anticus, there is associated some weakness of the other inverting muscles. In these instances the postural treatment alone will not be sufficient to restore the normal muscle balance, and recourse must be had to operation.

In using the term "muscle balance," I realize that I am using words about which we as yet know comparatively little. It is only in recent years that exact tests have been made to determine the ratio of the strength of the invertors to the evertors of the foot, and as yet no thorough statistical evidence has been presented on this important topic. Goldthwait, Painter, and Osgood, in "Diseases of the Bones and Joints," Chapter XII., record the ratio in 22 normal feet, as adductors, 10; abductors, 8.2. At the Children's Hospital in Boston, where the spring balance test has been carried out during the last few years, and certain tables of averages for different ages have been tabulated, the results show in general a predominance in the power of the invertors over the evertors; but the variation is so marked from one age to another that a certain degree of error seems probable. Thus, for the seven-year-old child, the ratio is 22 to 22; for the ten-year-old child, 35 to 30; for the eleven-year-old, 39 to 32; for the seventeen-year-old, 58 to 57. Nor are we much helped by the exact anatomical studies carried on by Rudolf Fick and his pupils. They have attempted to compute the relative strength of muscle groups by measuring the amount of shortening of each muscle, and computing the exact power

exercised by the muscle when contracting this particular distance. Fick's table, p. 629 of his "Anatomy of the Joints," Vol. III.,—computing the relative strength of the invertors and the evertors when moving the astragalo-calcaneus joint,—gives a ratio of 7.86 to 3.22. That is, the invertors are supposedly twice as strong as the evertors,—a fact which evidently clashes with the clinical data obtained by muscle tests on the living. Even the question of which muscles invert and which evert, is still subject to dispute, since, according to Fick, the tibialis anticus may be reckoned to the evertors as well as to the invertors.

My own studies of muscle balance, carried out with Biesalski, in 1914, brought out several significant facts in this connection, but still left the subject almost as unsolved as it had been before. Our work showed that the tibialis anticus acts as a strong invertor when the foot is below an angle of 90 degrees; that when further dorsiflexion occurs, the tibialis anticus loses some of this action and actually draws the foot into slight abduction. When, however, the action of the tibialis anticus is combined with that of the Achilles tendon, marked inversion and adduction of the foot occurs, irrespective of the amount of dorsiflexion.

Without going into further details of muscle balance, for clinical purposes I have been accustomed to follow the simple rule that the invertors should slightly out-balance the evertors, and that when this ratio does not hold, normal muscle balance does not exist.

In this second type of case, the disturbance of muscle balance is sufficiently accentuated to justify the attempt to increase the strength of the inverting muscles by tendon transplantation. For this purpose I use one of two muscles, depending upon the grade of paralysis. In the lighter cases, the extensor proprius hallucis is used; in the more severe cases, the peroneus longus. Under no circumstances do I approve of using the peroneus brevis, since this muscle has such a low point of origin that it cannot be transformed into an inverting muscle unless practically all of its muscle fibres be cut away from the bone. In the operative technique, I employ the sheath method described by Biesalski and myself. The insertion of the paralyzed tibialis anticus is first exposed, then the upper end of the tibialis anticus sheath. Through a small opening in the sheath, an eye probe carrying a guide ligature is passed downward through the sheath and made to emerge over the insertion of the tibialis anticus tendon. The tendon to be transplanted is then exposed and is drawn downward through the sheath of the tibialis anticus by means of the guide suture. In transferring the peroneus longus, a fascial plastic is a physiological necessity, since otherwise adhesions would be likely to occur where the

tendon crosses the septum inter-musculare anterius, separating the lateral from the anterior muscular compartments of the calf. This plastic consists in cutting a trap-door in the fascia of each of these muscular compartments, everting the fascia so as to expose its deep surface covered with gliding tissue (paratenon), and uniting the two fascial edges by means of a Lembert's suture, exactly as in executing the serosa suture of a gastro-enterostomy. The transplanted tendon, either the extensor proprius or the peroneus longus, is attached to the bone at the insertion of the tibialis anticus by a firm suture which assures mechanical fixation until physiological fixation has occurred. Animal experimentation, as well as observations at secondary operations, have shown that this physiological fixation of the tendon occurs within sixteen days; accordingly, after this period it is safe to begin active exercise of the transplanted tendon.

Type III.

This group of cases includes those in which there is complete paralysis of all the invertors except the Achilles tendon. The method of operative procedure for cases of this kind is still unsettled in my own mind. The transplantation of the peroneus longus alone does not suffice to restore the preponderance of the inverting strength. Something additional must be done. I have, myself, tried a number of different expedients, but I am not convinced that I have yet found the satisfactory solution of the problem. In one instance, I transplanted the

peroneus-longus.

FIG. 1.—Paralytic flat foot of type 2, before and after transplantation of the
A: Before operation; B: After operation; C: Showing the voluntary power of inversion after transplanting the peroneus-longus.

extensor longus digitorum to the inner side of the foot. A flap incision was made, exposing the four extensor tendons near the metatarsal heads, each tendon was dissected out, and then the four tendons, fastened together, were brought through a subcutaneous channel to the inner side of the foot. The result, as pictured in Figure 2, was

FIG. 2.—Paralytic flat foot, type 3 (complete paralysis of all the invertors except the Achilles tendon). On the right, position of the foot before operation; on the left, the result one year after transplanting the peroneus-longus and the extensor longus digitorum. The middle illustration shows the voluntary power of flexion and extension and the ability of the patient to extend the toes, despite the transplantation of the extensor longus digitorum.

gratifying. In four cases, I transferred the extensor proprius hallucis in addition to the peroneus longus. The results in these cases were less satisfactory, owing to the fact that the extensor proprius is a much less powerful evertor of the foot than the extensor digitorum. Stoffel uses the peroneus tertius in conjunction with the peroneus longus; Kleinberg supplements the tendon transplantation by attaching the tibialis anticus to the tibia in such a way as to act as a check ligament. Whitman has suggested the "loop" operation, in which the tibialis anticus is bound around the extensor tendons in such a way as to convert them, supposedly, into invertors. None of these solutions, however, seems to me to be getting at the main difficulty, namely, the marked weakness which is bound to result from a complete paralysis of that most important inverting muscle, the tibialis posticus. Until some method of affording some substitute for this paralyzed muscle is found, our results are bound to be imperfect.

Type IV.

In this last group there is complete paralysis of all the invertors, including the Achilles tendon. Fortunately, this type of foot, in which

only the peroneal muscles and the extensor longus digitorum function, is seen but seldom. I have not found it advisable to attempt transplantation, but prefer a simple tenotomy of the active tendons, in addition to a bone stabilization at the ankle.

The after-treatment of all cases of paralytic flat foot demands as much attention as the preliminary examination and the operative procedure. A suitable appliance is always indicated until the surgeon is convinced that the weakened muscles have regained their maximum strength. In some cases, a light arch support is sufficient; in others, an outer bar calf splint with a strap on the inner side of the boot, holding the foot in the inverted position. Occasionally, a double bar calf splint, with foot-sandal, is necessary. Each case should be studied individually, and that type of support used which is lightest and yet able to do the work required.

Without post-operative muscle training, no tendon transplantation will succeed, and unless this muscle training be kept up for many months, some cases which promised well at first will prove utter failures.

To hold the foot in the proper position while the patient sleeps, a simple night splint of plaster of Paris or celluloid should always be employed.

Difficult though the problem of the paralytic flat foot may be, and unsuccessful though we still are in the treatment of many of the severer cases, the success attendant upon careful attention to every detail of the treatment in a large number of patients leads me to the optimistic belief that by further study, and by a frank avowal of our failures, we may soon reach a degree of knowledge which will enable us to cope successfully with every instance of paralytic flat foot.

OSTEITIS DEFORMANS (PAGET'S DISEASE), WITH A REPORT OF THREE CASES.

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OUTLINE.

Definition.
Historical: Literature.
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Synonyms.
Etiology.
  Predisposing Causes. { Age. Sex. Heredity.
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Diagnosis.
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Prognosis. { Life. Cure.
Treatment.
Report of Cases.
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Thanks.
Bibliography.

DEFINITION.

OSTEITIS DEFORMANS (Paget's Disease) is a symptom complex of unknown origin, characterized by minor subjective symptoms but important objective findings of deformities occurring chiefly in the skull and

long bones. Cervico-dorsal kyphosis, prominent clavicles, and diamond-shaped abdomen are found. It is a disease of late middle life and is progressive. As yet there is no cure.

SYNONYMS.

Depending upon the interpretation of the pathology as understood by various writers, there have been applied to this disease a great number of terms. Some of these are: senile pseudo-rickets (Barker), (Pozzi), fibrous osteomyelitis (Von Recklinghausen), localized osteomalacia (Ollier), hypertrophic osteosclerosis (Menetrier and Gauckler), hypertrophic deforming chronic osteomalacia (Schmieden), diffuse ossifying osteitis (Lancereaux), fibrous megalo-osteitis (Gauiciero), osteolyose (Lobstein), craniosclerosis (Huschke), hyperostose generalisée ostéite condensante (Volkmann), benign hypertrophic osteomalacia (Vincent).

English and American writers, as a rule, adhere to the terms osteitis deformans or Paget's disease of the bones.

HISTORICAL.

In 1876, Sir James Paget described a rare form of chronic inflammation of the bones, since called by his name. He presented a report of five cases before the Royal Medical and Chirurgical Society of London. Only two of these cases were his own. He saw his first case in 1856 but did not report it until twenty years later. One of the five cases had been previously described by Wilks in 1869, under the name of osteoporosis, or spongy hypertrophy of the bones, and, according to Gaenslen, the autopsy in this case (by Wilks and Goodhart) is probably the first on record. Preceding both Paget and Wilks, Wrany, in 1867, described a case which was undoubtedly a true case of this condition. Paget called it osteitis deformans, unaware of the fact that Czerny, in 1873, had used the term osteitis deformans in describing "a rare acute inflammation of the lower part of the tibia and fibula; inducing softening and angular bending, and followed by hardening." In 1697, Malpighi called attention to the diffuse hypertrophy of the skull, a condition which Virchow later called "leontiasis ossea" and thought by many to be very closely related to, if not a manifestation of, osteitis deformans.

The most important articles are those by Paget, Wilks, Czerny, Packard, Steele and Kirkbride, DaCosta, Funk, Bergeim and Hawk, Lannelongue, Gaenslen, and Hurwitz. The writer has quoted freely from these, as well as other excellent papers.

FIG. 1.—From Paget's original paper (Gaenslen).

INCIDENCE.

In 1901, Packard, Steele and Kirkbride made a careful study of the literature and found sixty-six cases typical of this disease. They added one case. In 1910, Higbee and Ellis estimated there were one hundred and eight cases on record. DaCosta, Funk, Bergeim and Hawk found fifty more up to June, 1914, and added three more. Funk brought the number up to two hundred and thirty-two, June 1, 1917, since which time the author found sixteen cases in the literature. With the three cases reported in this paper, the total number to date is about two hundred and fifty-one.

FIG. 2.—From Hutchinson's paper (Gaenslen).

FIG. 3.—Skull from a case of osteitis deformans (Frangenheim).

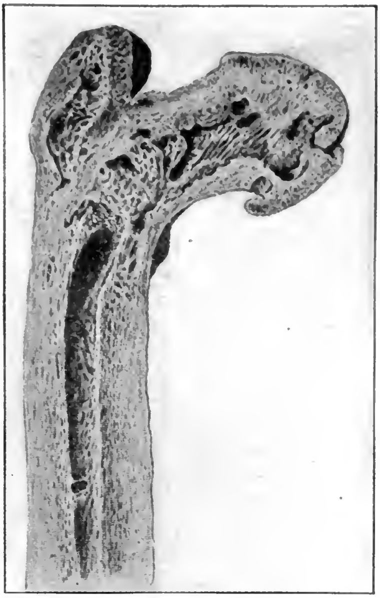

FIG. 4.—Cross-section of the upper end of the femur (Frangenheim).

In 38,000 records of the New Jefferson Hospital, covering a period of seven years, there were only three cases of Paget's disease (Funk), and Hurwitz found three cases in 30,000 medical admissions to Johns Hopkins Hospital.

ETIOLOGY.

Predisposing Causes.

Age. The average age of onset in fifty-one cases studied by Packard, Steele and Kirkbride was 49½ years. Various writers have reported cases starting very young, *viz.*, Sonneberg at sixteen years, Elsner at twelve years, Jones at sixteen years, Thibierge at thirteen years, Hartman at fifteen years. In one case of DaCosta *et al.*, the head involvement began at eight years of age. The oldest recorded age of onset was seventy-nine years. Stillings' ninety-two years old case has no data concerning onset.

Sex. Males are more frequently affected in the proportion of about six to five.

Heredity. Heredity is said to be of importance in approximately 7% of cases. For example, a father and two sons (Oettinger and LaFout); two brothers (White) (Lunn) (Abbe); two sisters (DaCosta *et al.*) (Parry); mother and son (Higbee and Ellis) (Berger) (Hur-

FIG. 5.—Author's case No. 3.

witz); mother and daughter (Chauffard); brother and sister (Kilner) (Walter); father and son (Smith); father and daughter (Pick).

Color. Color does not seem to be important although two of the herein reported cases are negroes.

Exciting Causes. As regards the exciting cause of osteitis deformans, it is practically as obscure today as it was at the time of Paget's original communication forty-five years ago. There are many theories, the most important of which are: Syphilitic, infectious, endocrine, neurotrophic, metabolic.

Syphilis. Paget believed it was not associated with syphilis, but was due to a chronic inflammatory process. The French, however, notably Lannelongue, Fournier, Ettienne and Vergne, believe that it is a late manifestation of hereditary syphilis. The English and American writers do not believe in the syphilitic theory and regard that disease as of relative unimportance. It seems to be definitely in evidence that Wassermann tests are usually negative, and that antisyphilitic treatment is of no avail.

Chronic Infectious Theory. There are those who believe that a chronic low-grade infection from any source may produce bony changes such as those found in Paget's disease. Some of these writers are of the opinion that this condition and arthritis deformans are manifestations of the same disease. The concurrence of Paget's disease with arthritis deformans, cardiovascular disease and carcinoma has led various writers to assume a close relationship between them; but this evidence is merely speculative.

Morpurgo, Archangeli and Fiocca found a diplococcus in the bones of animals in which osteomalacia had been produced experimentally, and in the iliac bones of women suffering with the disease. They prepared a vaccine and reported favorable results in the treatment of thirteen cases of osteomalacia and one case of osteitis deformans. Archangeli believes that osteomalacia, rickets, and Paget's disease are manifestations of the same disease and upon this assumption conducted further observations. An organism similar to the one previously found was isolated from the tibia of a woman with Paget's disease and a vaccine prepared. It was given four cases with decided improvement in two cases, beginning improvement in one and no manifest change in the fourth. DaCosta, Funk, *et al.*, tried to make a vaccine, but culture and animal inoculation experiments were negative.

Neurotrophic Theory. In 1883, Lancereaux expressed the belief that Paget's disease had as an underlying cause a disturbance of the nervous system. The relationship between bone dystrophies and nervous conditions was offered as an argument. Pitres and Vaillard thought it was due to degeneration of the nerves entering the nutrient foramina. Recklinghausen's case showed at autopsy chronic myelitis. Various writers have described lesions of the medulla, of the peripheral nerves, involvement of basal tracts and spinal cord. There has been no constancy of autopsy reports. The disease has been described in a tabetic and in association with Huntington's chorea. Emerson believes the cord changes are due to arteriosclerosis. It is the writer's belief that disturbances of the nervous system may be the underlying cause of a disturbed metabolism in some cases and therefore indirectly cause osteitis deformans, the intermediary being the ductless glands.

Endocrine Theory. Many writers have tried to demonstrate the relationship between Paget's disease and pathology in the ductless glands, notably the thyroid, parathyroid, pineal, suprarenal, and pituitary. There has been no conclusive evidence to warrant such interrelationship because in the comparatively few cases examined pathologically definite chances were not constant.

Metabolic Theory. The most complete metabolic studies which have been made of this condition are those described by Bergeim and Hawk, whose investigations revealed a decided retention of calcium, magnesium, and phosphorus, and a pronounced loss of sulphur. These findings were interpreted as indicating a stimulated osseous or osteoid formation, accompanying the absorption of a highly sulphurized organic matrix. In advanced osteitis deformans the first step in the new formation of bone or osteoid tissue may be the production of a highly sulphurized organic matrix which is transformed gradually by a calcification process, which is accompanied by the deposition of calcium magnesium and phosphorus in this matrix. In the course of this calcification process they suppose that a certain quota of the sulphur of the matrix is replaced by the other elements mentioned, a process which must entail the retention of calcium, magnesium, and phosphorus, and an accompanying increased elimination of sulphur. They believe that the metabolic picture of osteitis deformans is, to a certain degree, that seen in osteomalacia. Arteriosclerosis of the nutrient arteries of the bone has been regarded as the cause of the disease by some. This theory is not borne out by the fact that arteriosclerosis is a very common condition, especially in advanced age, during which period Paget's disease should be very common, whereas it is a very rare disease at any age.

Tubby described marked relief in one case in diet, and therefore believes that disturbed metabolism may be the cause.

Pathology. As the three cases reported in this paper are still alive, it is necessary to review the literature for a description of the pathology. The articles of Paget, Packard, Kirkbride and Steele, DaCosta, *et al.*, are freely quoted.

The pathology is chiefly in the bones and may be generalized or localized; the latter are the so-called non-osteitic types. This is the term applied by Schlesinger, and cases have been described by him, Schirmer, Bowlby, and Hurwitz. They described cases of inflammation of a single bone. Paget and the early writers believed that multiple bone involvement was constant.

The gross pathology consists in the deformities, most common of which is outward and forward bending of the tibia. Next in frequency is the femur, and then the other long bones. The tibia shows its greatest thickening on its convex surface and the outline is wavy on that surface. The joints are scarcely ever involved in the disease, although in advanced cases there may be limitation of motion of the hip (coxa vara), ankle, knee, or elbow, due to the thickening deformity of adja-

FIG. 6.—Author's case No. 3.

cent bones. The occurrence of fractures is not increased in frequency.

The occurrence of the deformity is most frequently manifested in the lower extremity, probably because of the effect of weight-bearing. Gradually the skull or clavicle may be the first bones involved even in advanced stages of the disease, although various writers have described various bones as being involved first, namely, the external malleolus, bones of the feet, metacarpals, phalanges. These observations are rare and unusual. In Levi's case neither tibia was involved. The involvement is usually symmetrical, although there are cases reported in which the disease was limited to one-half of the skeleton. Marie and Leri describe peculiar anomalies in the skulls of persons who have had Paget's disease and report the unexpected discovery of extensive syringomyelia at necropsy in one case. They theorize to explain this by mechanical factors.

FIG. 7.—Author's No. 3.

The entire thickness of the cranium is composed of finely porous bone substance, with a thin inner and outer plate of harder bone. The diploe is lost. Microscopically, the porous substance consists of a network of thin bony processes. Haversian canals are confluent as a result of absorption forming Howship's lacunæ which Butlin believed were characteristic of bone inflammation. The lacunæ contain numerous giant cells, leucocytes and fat cells in a vascular connective tissue matrix. There are scattered areas of newly formed bony tissue. The osteoblasts of this new bone, while present in considerable numbers, are not so plentiful as in normal growing bone and are arranged irregularly. The branching processes of the new canals are shorter than normal or are entirely lacking. The new osteoid substance remains uncalcified or is reabsorbed. There is sharp demarcation between the new and old bone indicating their independence. Most observers believe that the regenerative process originates in the periosteum or from the dura, while Von Recklinghausen claimed its medullary origin. Packard, *et al.*, believed it came from the periosteum.

The result of the coincident absorption and regeneration is a total

destruction of all symmetry in the internal architecture of the bones. As a rule, uncalcified new bone renders the cranium soft, but in some areas there is sclerotic bone of ivory-like hardness. In the long bones the normal relation of compact and cancellous structure is destroyed. The outer walls of hard bone are represented by thin, irregular plates lying directly under the periosteum. In general, the histology is like that of the skull, except that the medullary substance is more fatty, and that the retrogressive and progressive changes (Von Recklinghausen) are observed. The former produce cysts filled with gelatinous material; the latter produce fibrous tumors or giant-celled sarcomata. An instance of the latter occurring in the skull is reported by Packard, *et al.*

In the bodies of the vertebræ the histological changes are practically the same as in the skull.

Hurwitz states that however at variance writers may be regarding the initial step in the progress, all who have studied the pathology of the bony changes describe a similar microscopic picture; essentially this consists of a resorption of bone associated with the excessive production of a poorly calcified bone designated as fibro-osteoid tissue.

From a careful pathological study Higbee and Ellis believe that resorption of bone appears to be the initial histologically recognized change. The reparative processes alone should be regarded as inflammatory in nature, which follows the resorption of bone, and results in new bone formation.

Barker describes this condition as senile pseudo-rickets with softening due to a rarefying osteitis and thickening due to periosteal medullary new bone formation.

Morton Prince divides the Pathology into three stages; any one process predominating: (1) Absorption of bone. (2) New formation of bone without calcification. (3) New formation of bone with calcification.

Pathogenesis. It appears to the writer that this condition is a combination of two definite pathologic conditions, namely, osteoporosis, followed by osteosclerosis; that the condition begins as an osteomalacia with softening due to the abnormal interrelationship between various chemical substances in the bone. During this stage deformities occur. Then, for some unknown reason, the condition of osteomalacia disappears and is replaced by osteosclerosis, during which stage the cortex of the bone assumes a certain hardness (often ivory-like) which is typical of advanced osteitis deformans. (This fact must be considered in making x-ray exposures.)

After a careful study of the literature, the writer is impressed with the fact that many authors have been describing different stages of the same general condition. One writer sees a case, or a group of cases, with pronounced osteomalacic signs and symptoms; another writer does not see this type at all but meets those cases that have gone past the stages of osteoporosis into the condition of osteosclerosis. One is impressed by the similarity between osteitis deformans and rickets as seen in children; in the latter condition one patient is presented with the marked softened condition of the bone during which period deformities occur. Subsequent conditions of deformities do not progress, and the bones, instead of being soft and easily bent, have assumed an advanced degree of hardness, during which stage it is even difficult to drive a chisel through them.

The work of Goldthwait, Painter, and Osgood would seem to indicate that in osteomalacia there is at first a decalcification of the bony tissue; that the calcium is in part replaced by magnesium but probably chiefly by an organic substance rich in sulphur, poor in phosphorus, similar to, but not exactly like, the normal organic matrix. If castration is performed during this period, the decalcification process is checked and what has been lost is replaced. From Newman's work they believe that if the condition has lasted until it is very severe the decalcification process finally comes to an end, but that after this stage castration does not restore the normal calcium metabolism. The hypothesis, that the process of decalcification is a solution of the calcium by an acid similar to the solution which takes place when dead bone is placed in hydrochloric acid, does not seem justified.

Signs and Symptoms. The onset of this condition is slow and may be spread over many months or years. The patient usually gives a history of vague "rheumatic" pains in the extremities, symptoms which are in no way different from those described as ordinary rheumatic. They are probably due to stretching of the periosteum caused by the deposition of inflammatory products and new bone beneath it. The late pains are probably due to distortion of the joints. There is a gradual weakness of the lower extremities, tenderness along the shafts of the bones, especially the tibia and femur, a long story of gradual decrease in height. Osler describes one case where thirteen inches in height was lost. The patient notices that his friends are growing taller. He might notice that he is having increasing difficulty in turning off a gas jet or an electric light, or that the mirror that he formerly used very comfortably while shaving, seems too high for him. A woman might experience analogous sensations. The first symptom might be

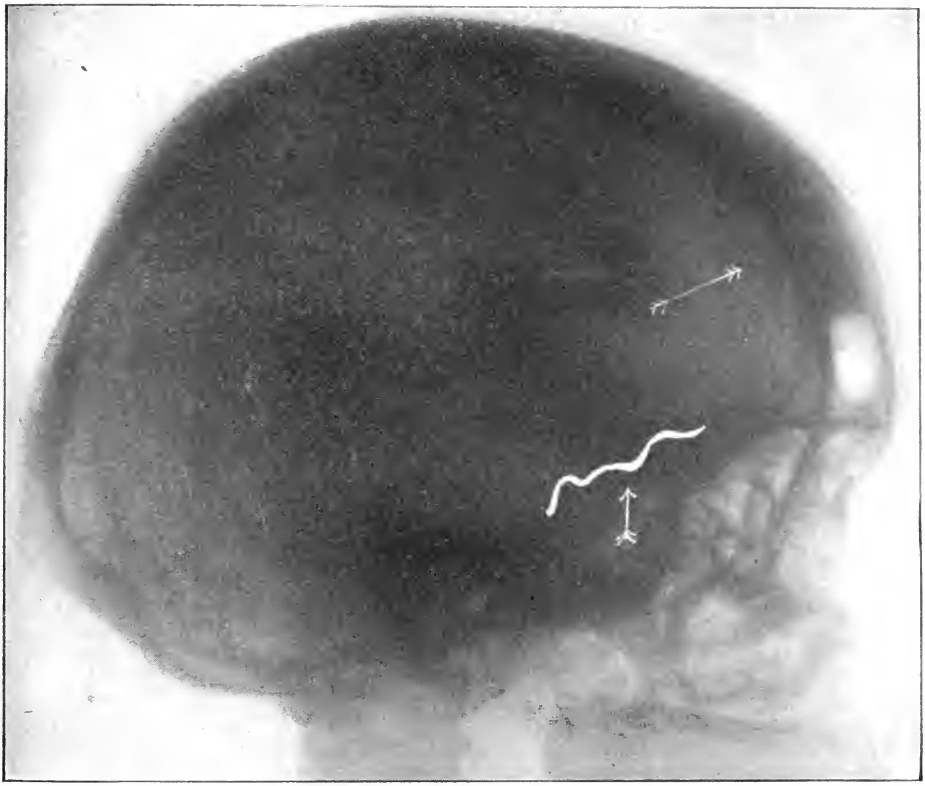

FIG. 8.—Author's case No. 3.

increasing size of head as noted by frequent buying of larger sized hats. White reported a case in which the hat size increased from $6\frac{7}{8}$ to $8\frac{1}{2}$. Because of the increase in size of the skull the face seems small.

There is in the Dupuytren Museum in Paris a specimen of a skull, from a case of osteitis deformans, which is about an inch and a quarter in thickness.

Deformities occur in the long bones, most common of which is the outward and forward bowing of the tibia; next in frequency the femur, with a similar deformity. Foote's case measured 30 cm. between the patellæ when standing erect with the heels together. The head is usually flexed so that the chin approximates closely the sternum. This is partly due to the increased weight of the head incident to the enlargement of the skull and to the deformity of the spine, which is so very common; namely, cervico-dorsal kyphosis. There is in some cases,

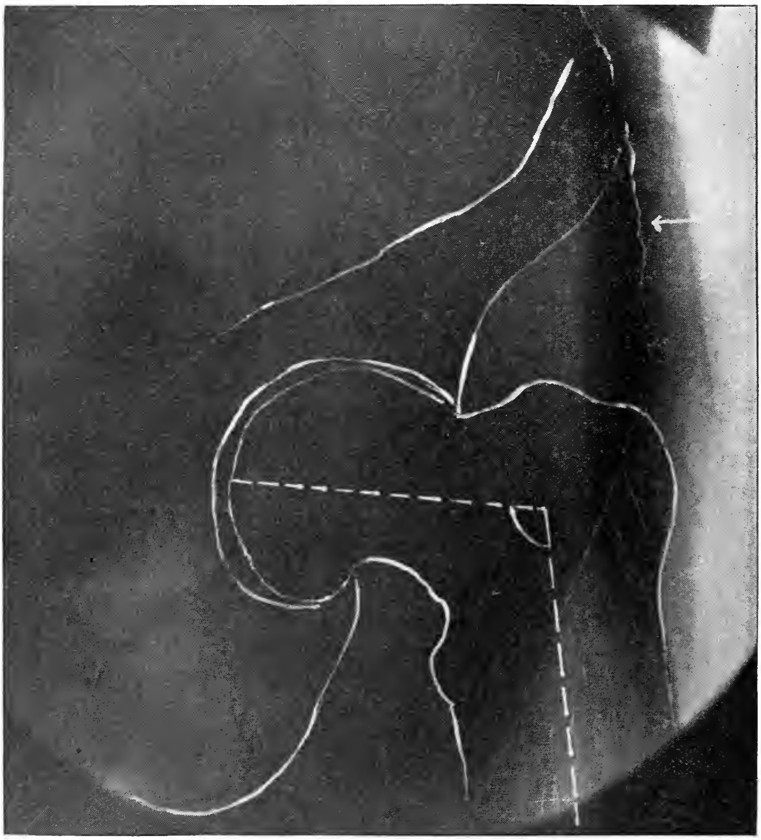

FIG. 9.—Author's case No. 3.

as notably in one case reported in this paper, deformity of the clavicle, which is chiefly shortening with thickening about the middle, which may impress one as having been a fracture with overgrowth of callus.

The abdomen assumes a diamond-shape with its four points at the ensiform cartilage, the symphysis and the two ilio-costal angles. Instead of the normal space between the costal margins and the crests of the ilia, admitting three or four fingers, there is often insufficient space to permit the introduction of one finger. There is usually a prognathian chin and, with the appearance of unusually long arms, the patient assumes a marked resemblance to the anthropoid ape *i. e.*, the "simian" appearance. This is so striking that most of the cases seem to bear a family resemblance to each other.

A symptom or associated condition is that of morpheo-scleroderma.

There has been one case of this described by Pernet, and Case 3 of this series shows a somewhat similar condition.

The first roentgenologic examination of Paget's disease in France was made in 1901 by Gallois at Beclere Institute in Paris.

X-ray findings are typical, showing rarefying osteitis with a thick cortex due to subperiosteal and medullary new bone formation. This thickening occurs on the convex surface. The bone has the appearance of cotton-wool or of the hair of the pickaninny. This occurs in both the diaphysis and epiphysis. There may be bony striations extending out into the soft tissues, parallel with the long axis of the bone. There may be seen early in the x-ray areas of rarefaction. The cortical zone is more transparent than normal, owing to the thinning of the subperiosteal layer. The spaces are clear. Careful x-ray study by Hayhurst and Hartung revealed the following: Marked bowing and enlargement of long bones and hyperostoses on and thickening of flat bones. Minute changes found in all the bones affected were a coincident porosis and sclerosis, one or the other process predominating in different parts. Fine markings, ordinarily shown in the cancellous ends of long bones, were replaced by a coarse trabeculation which extended into the shaft for a variable distance, in some instances involving the entire bone. In places, subperiosteal thickening was clearly discernible, while in others, decalcification beneath the periosteum had progressed irregularly, simulating caries. Near the distal end of both radii and ulnæ of one case uniform absorption of a limited area had occurred resembling cyst formation. In the tibiæ of two cases the lumen of the medullary canal had been largely encroached upon by irregular lamellæ of bone. With the exception of the spine, joints were not involved. The process extended throughout the epiphyses but there was no noticeable irregularity of the joint surface, nor was there any undue approximation of the articular surfaces suggestive of atrophy of joint cartilage. The spine of the man was partially ankylosed, while that of the woman showed a definite angulation at about the 3rd dorsal vertebra, suggestive of Pott's disease (past or present).

Both skulls showed well marked and similar changes. Calvarium was markedly thickened, especially at base. External hyperostoses were clearly apparent as well as abnormal porosity in places. Sella turcica was approximately normal. In the man, advanced arteriosclerosis of upper and lower extremities as seen in x-ray.

Perkins' case presented the leonine type of skull with thickened inner and outer tables, a moth-eaten appearance due to porosity of the outer plate. The sella turcica was small, 10x10 mm. (normal 12x15 mm.), and

there was a shadow suggesting a calcareous roof over the pituitary fossa. Frontal and maxillary sinuses simulated acromegaly in that they were large, having a blown-out appearance. The posterior portion of the sphenoid was unusually dense. The chest showed thickened clavicles and ribs.

In 1902, Kienböck stated that Paget's disease and syphilis could be differentiated roentgenologically.

Goldthwait, Painter, and Osgood believe that new bones may become affected without the knowledge of the patient and give rise to no subjective symptoms. This occurred, for example, in a noted organist and pianist whose hands were x-rayed in the routine examination of a well-marked case. Several of the metacarpals and phalanges showed definite changes which seemed to be of long duration, yet had not interfered with his vocation in the slightest degree.

Abbe found four cases of jaw complication in fourteen cases.

McCrudden, working under the direction of Goldthwait, Painter, and Osgood, found the calcium in the urine high, the magnesium a little low. There was a slight loss of phosphorus and a slight retention of calcium and magnesium.

Complications or concomitant conditions have been variously stated as neuralgia, cardiovascular disease, myocarditis, cardiac dilatation, fractures, osteoarthritis, insanity, arteriosclerosis, and malignant sarcoma. It is probable that none of these (excepting the last) is important. Foote reported an interesting case of osteitis deformans with heart complications and involvement of the liver and spleen.

DIAGNOSIS.

The correct diagnosis is easy in the advanced stage, but it is almost impossible before the stage of deformity has occurred. In the advanced stage the clinical picture is so typical that the diagnosis is simple. Before the deformities have occurred it may be speculative only. It is reasonable to believe that with the perfection of metabolism studies the future will show many diagnoses of this condition, before much deformity has occurred.

Differential Diagnosis.

The diagnosis of Paget's disease consists chiefly in its differentiation from syphilis, osteomalacia, rickets, bone tumors, acromegaly, and hyperostosis diffusa cranii.

FIG. 10—Author's case No. 3.

In syphilitic disease of bone the x-ray shows little or no encroachment upon the medullary canal; the bone is denser. Cortical thickening is found on the convex surface of the deformity. There is no lack of calcification. Other signs of syphilis are usually present, and the Wassermann reaction positive. The therapeutic test of anti-syphilitic treatment will often determine the diagnosis.

Hyperostosis diffusa cranii of Virchow is probably a manifestation of osteitis deformans. Cranial nerve involvement is frequent, due to encroachment upon the foramina and fissures at the base of the skull.

Differential diagnosis of bone tumors must be made upon a careful history and physical examination, taken together with the x-ray findings. The diagnosis of rickets is made from the age of the patient, and x-ray.

In rickets the thickening of the cortex occurs on the concave side (Lovett), in Paget's disease on the convex side.

Osteomalacia involves the bones of the trunk more frequently than the extremities and usually does not involve the cranial bones, and in the senile form there is much pain. There is no bone hypertrophy such as occurs in Paget's disease. The predilection for the bones of the pelvis and the lumbar spine are striking features in osteomalacia. Again, osteomalacia is very rare in the male, whereas Paget's disease is more common in the male.

Quoting from Elliott and Nadler: Dock found reported in this country up to 1895, only eleven cases of osteomalacia, all in the female. Hahn, in 1899, was able to collect from the literature forty-two cases in males, but the diagnosis in some of these cases was in doubt. McCrudden, in 1910, stated that among three hundred and sixty cases of osteomalacia reported by five writers, thirty-nine were in men. Without making a special search he found reported in the last twenty-five years ten cases in unmarried females and nine cases in males. In four of the latter the diagnosis was confirmed by necropsy.

The case of Elliott and Nadler was a man of thirty-four years on whom Kanavel had done a double castration, the only recorded male so treated, and I quote their conclusions: Five years after castration the case reported shows no actual improvement in bone structure. A probable remission has occurred, which may have been influenced by the operation. The result of castration in this patient would seem to indicate that osteomalacia is not a disease of the sex glands.

The writers state that the early involvement of all the bones is characteristic of male osteomalacia.

The loss of calcium and the softening of the bone, together with a new production of bone, poor in lime, are characteristic. There is a tendency to lime deposit elsewhere, as in the kidneys and bladder. McCrudden believes that osteomalacia is an exaggeration of a normal function, that the balance of bone metabolism is disturbed by excessive demands for calcium, as in pregnancies, bone tumors, and fractures. When bone katabolism exceeds anabolism the result is osteomalacia (For full bibliography on osteomalacia, see article by Elliott and Nadler).

There is a point in differential diagnosis between osteomalacia and Paget's disease, which has not been seen in the literature; namely, that when a person with Paget's disease grows smaller, he is small all day long, but the osteomalacic has a diurnal cycle, which is beautifully illustrated in Elliott and Nadler's case, by what the writer terms the

mirror test, *viz.*: Their patient told the writer that if he shaved soon after a night's sleep, the mirror was on a level with his eyes, but if he shaved at night, it was too high for him. This is explained by the fact that during the day his height gradually decreased due to body weight on soft bones; during the night his height increased considerably. No doubt an important rôle is played by the compression and relaxation of the intervertebral discs. He stated that he stood several inches taller in the morning than at night.

PROGNOSIS.

The prognosis as to life is good, some patients living to the 8th decade. One case in this series is a woman sixty-nine years of age. Stillings' patient was ninety-two years old.

The longest duration of the disease is recorded by Moizard and Bourges, in whose patient the condition existed fifty-two years before death.

The prognosis as to improvement is not good; as to cure, absolutely bad. It is probable that once a patient becomes bedridden from the disease, he will never walk again.

Death is usually due to intercurrent infection or malignancy.

TREATMENT.

Preventive treatment is impossible because of the difficulty of diagnosis before deformity has set in. Curvative treatment at present is impossible. Corrective treatment may be inadvisable because of the age of the patient and the probability of failure. Funk hopes to offer something of value in the treatment from the standard of calcium metabolism. Arsenic has been given internally in all its forms, and the results are questionable.

There have been recommended by various authors: prepared bone marrow, cod liver oil, calcium lactate, thymus gland. One writer recommended giving proteins, but no carbohydrate.

For the present, it seems that the best hope is offered by the administration of phosphorus internally; for example, in the phosphorus pill of a hundredth of a grain three times a day, continued over a long period.

Goldthwait, Painter, and Osgood reported a case which suffered a fracture of the affected thigh from a severe trauma. The broken bone healed with apparently normal rapidity and firmness. This encourages

them to recommend osteotomies for the correction of marked but slowly developing deformities, especially of the lower limbs.

Abbe found excellent operative repair of bones affected with osteitis deformans. He cites two jaw cases operated upon with perfect results.

REPORT OF CASES.

The writer desires to report three cases.

Case 1. W. H. Male, age 47. Born in Minnesota of French-Indian-Negro and English parentage. For the past twelve years has been getting more "bow-legged." Has "pain going down his legs." They always feel weak; tire very easily. His condition has been diagnosed softening of the bones. He thinks for the past ten years he has lost four or five inches in height. Married fourteen years, four children, all well. No deformities in his family, except that his mother was "bow-legged." He had marked forward and outward bowing of the legs, involving tibia, fibula, and femur, and both tibiæ were markedly flattened laterally.

Case 2. A. E. K. Female. Patient referred to Dr. J. L. Porter by Dr. W. H. McCoach of Houston, Texas.

Case 3. E. L. Age 69, negress. Born in Tennessee. Father died of pneumonia, mother of carcinoma of the stomach, brother died of cholera at the age of three years. Family history negative. Her husband was killed accidentally thirty years ago. He was in very good health, and the patient states he never had any venereal disease.

Present Complaint. The patient complains of marked deformity of the bones of her legs, especially the right. Trouble began about four years ago, since which time she has been unable to walk or even stand. Sharp shooting pains throughout the body, especially at night. Sleeps very little after midnight. She first noticed right leg bending, later the other leg and both arms. Twenty years ago a window fell on the left forearm, incapacitating that member for six months.

Past History. "Rheumatism" in 1871. She had twelve pregnancies, four children living, no miscarriages; four daughters married, none of them had miscarriages.

Physical examination reveals a fairly well-nourished colored woman, approximately sixty-five years of age. She is bedridden, but does not appear acutely ill. There is an anterior, sabre-like curvature of both femurs; the right tibia and fibula in their lower third are bent to an angle of nearly ninety degrees. There is a bony prominence in the lower third of the left forearm. There is an outward bowing of both forearms. Angular kyphosis of the cervico-dorsal region. The curves of both clavicles are markedly exaggerated. There is a prominence about the middle of each clavicle suggesting the overgrowth of callus as in an old fracture. Both clavicles are markedly shortened. The skin over the lower legs is very shiny and tight (scleroderma). The pupils are equal and react to light and accommodation; reflex normal: knee jerks normal. Abdo-

men is diamond-shaped. It is with difficulty that one finger is inserted between the costal margin and the crest of the ilium on each side. The abdomen is somewhat tense, liver appears to be enlarged two fingers' breadth below the right costal margin. Heart and lungs normal. Chin is markedly prognathian, and the head is flexed on the chest.

X-ray report by Dr. E. L. Jenkinson. There is definite thickening of the cranial vault, with a generalized osteoporosis of the bones of the skull, especially in the occipital region. The sella turcica is very shallow and elongated with the clinoid processes indefinite.

The cervico-dorsal region of the spine does not give definite x-ray shadow because of the kyphosis in this area and the osteoporosis.

There are several infractions of the ribs.

There are three fractures of the bones of the left forearm: radius at junction of middle and upper thirds with no union; ulna two fractures in upper half of bone with very little evidence of union.

Bilateral coxa vara; the angle subtended by the neck and shaft is slightly greater than a right angle.

The bones of the lower extremities are universally rarefied, with fine and coarse trabeculæ scattered throughout. There are areas of periosteal bone proliferation. There is a very marked angular deformity just above the right ankle and a gradual forward curve of the left tibia. Diagnosis—Paget's disease.

Urinalysis, normal; blood examination, normal; Wassermann, negative.

CONCLUSIONS.

The justification for reporting these three cases lies chiefly in Case 3, which is unusual in the following respects: the marked deformity of the right lower leg, the skin condition (scleroderma), and the fractures of the left forearm, which show non-union roentgenologically after twenty years. The last fact proves that she had some disturbance of bone metabolism many years without much inconvenience.

I desire to express my thanks to Dr. John Lincoln Porter for the privilege of reporting these cases; to Dr. D. B. Phemister for confirming the diagnosis of Case 3, and to Dr. E. L. Jenkinson, roentgenologist at St. Luke's Hospital.

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CHRONIC OSTEOMYELITIS SECONDARY TO COMPOUND FRACTURE.

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MOST of our soldiers with chronic osteomyelitis, following gunshot wounds received in the World War, are now out of service. Nearly all these men have been discharged with healed wounds. Unfortunately, recurrences and sequelae are frequent. These men are scattered all over the country. In view of this fact, and in view of the fact that the problems involved in treating osteomyelitis secondary to compound fractures in civil life are similar to those involved in treating cases secondary to gunshot fracture, it is believed that the results ob-

tained and the methods employed in the treatment of 359 such cases on the writer's section of the surgical service of this hospital, between August, 1919, and August, 1920, will be of general interest.

The osteomyelitis in these cases followed compound fracture resulting from gunshot wounds in nearly all instances. The wounds had been received from nine to fourteen months previously. All cases had been operated upon once or more. Of the 359 cases, 188 required further operative work as follows:

Bone operations, 143; plastic operations, 56; drainage abscess, 36.

Table 1 gives a complete résumé of the part involved, operative management and results obtained in the 143 bone cases. It is of interest to note here that an average of six operations for osteomyelitis has been performed, in various hospitals, on our patients who have been under treatment for two years.

Of the original 359 cases, 33 are still in the hospital, unhealed. These cases are distributed as follows:

Extensive osteomyelitis of shaft of femur	15
Epiphyseal cavities	5
Complicating soft part defects	4
Extensive osteomyelitis of shaft of humerus	2
Extensive osteomyelitis of pelvis	2
Extensive osteomyelitis of tarsus	2
Extensive osteomyelitis of bones of shoulder	1
Extensive osteomyelitis of pelvis and head of femur	1
Extensive osteomyelitis of tibia	1

These cases will be considered again later.

OPERATIVE TREATMENT.

The operations adapted to the radical cure of osteomyelitis secondary to compound fracture are sequestrectomy, effacement, resection, and amputation. Sequestrectomy alone has been found to be unsatisfactory unless the sequestra is free in the soft tissues and no tunnel or bone cavity exists. Where tunnel or cavity exists in the shaft of a long bone, it must be effaced in such a manner as to allow the soft parts to collapse into and fill the defect (Figures 1 and 2). The end-result of extensive effacements is excellent. Under the stimulus of use, the bone tends to regain its strength and normal contour (Figure 4). At or near the epiphysis of a bone, complete effacement is not possible without entering the joint. In such a case effacement should be done distal to the joint and an attempt made to fill any

defect into which the soft tissues will not collapse by turning in a muscle flap. Such operations are less effective than where simple collapse of the tissues fills the defect. In our series there were six successes in ten such operations.

The most ideal method of treating chronic osteomyelitis is by resection of the entire diseased area. This method is the method of choice in cases of osteomyelitis of the rib, carpus, or individual tarsal bones. It is also applicable to certain cases of osteomyelitis of tibia or fibula, or of radius or ulna where the entire thickness of a portion of the shaft is necrotic. In such cases bone graft is employed to fill the defect after healing occurs. Resection of joints for osteomyelitis of the end of one or more of the bones entering into the formation of the joint is practical, in the upper extremity, where shortening is of secondary importance. Usually in the lower extremity to obtain results so much bone must be removed that hopeless shortening occurs. Amputation is therefore preferable (Figure 5). In case of osteomyelitis of head and neck of the femur, amputation cannot be followed by a satisfactory artificial limb. In such cases resection, to be followed by transplantation of head and part of the shaft of the fibula, has been suggested (Figure 7).

AMPUTATION.

Amputation should be the last resort in the treatment of osteomyelitis. However, experience has shown that it is a mistake to delay amputation in certain cases. This is particularly true in cases of extensive osteomyelitis of the tarsus or of the epiphysis of the long bones of the lower extremity, where resection is impractical (Figures 5 and 6). Spongy bone lacks the resistance to infection and the regenerative power of compact bone. For this reason in six cases of extensive osteomyelitis of the tarsus that the writer undertook to save, five were later amputated and the sixth patient would probably also have been better off with an artificial leg. It is the writer's belief that if such cases are not healed within six months, amputation should be performed. Eight cases in our series were amputated for the following:

Extensive osteomyelitis of tarsus	5
Osteomyelitis lower epiphysis of tibia	1
Osteomyelitis lower epiphysis of femur	1
Severe streptococcus infection of knee (As last resort to save life)	1

To obtain results in the management of chronic osteomyelitis cases, attention must be paid to pre-operative, operative and post-operative treatment. Every effort should be made to put the patient in the best possible physical condition before operation. If the patient is badly run down, particularly if he runs a temperature, it is best to open the wound widely and Dakinize as a preliminary to extensive bone operation. It is not good policy to do extensive bone operations when pus pockets exist: free drainage and Dakinization should precede. By observing these precautions we had no deaths as a result of osteomyelitis. Pre-operative attention to the part should consist of putting the surrounding skin in good condition by occasional shaving, daily cleaning with neutral soap, and protection from irritating discharges by the use of vaseline strips. Dakinization of existing sinuses or wounds for a few days prior to operation does much to insure success by decreasing the number of organisms.

OPERATIVE TECHNIQUE.

Operation should aim at complete eradication of diseased bone, excision of existing sinuses, and removal of scar tissue. To accomplish this ample incisions must be made. In studying the cause of operative failures insufficient exposure was found to be the commonest cause. In many cases counter incisions are required. Incisions should be made that will best expose the diseased bone. The so-called incisions of election should be employed only if they fulfill this requirement. Knowledge of anatomy will enable the operator to recognize and retract from the field any blood vessels or nerves that might be injured. Considerable aid can be obtained by injecting existing sinuses with methylene blue before beginning to operate. A tourniquet is also of aid, particularly on the lower extremity. It should not be employed if it will limit necessary exposure. Good exposure of the diseased bone having been obtained, the periosteum should be stripped back only from the bone area to be removed. Before using the chisel, the soft parts should be protected by gauze compresses, moistened with salt solution, to prevent bone fragments being retained in the wound, and later acting as sequestra. Removal of the diseased area *en bloc* is best on this account. All projecting edges should be leveled and bleeding stopped before the operation is concluded.

The use of chemical sterilizing agents at operation has been widely advocated. In many of our cases the effaced area was swabbed with

carbolic acid followed by alcohol. In other cases we have employed ether. It is believed that these procedures are valuable but that they cannot replace careful surgery. The removal of diseased bone and scar tissue back to sound and healthy tissue is the secret of success.

Results of Different Methods of Treatment Employed

	TOTAL CASES.			Bone Effacement. Wound granulating from bottom			Bone Effacement. Wound partially sutured.			Bone Effacement. Zinc Chloride Method		
BONE INVOLVED:	Operated	Healed	Unhealed	Successful	Failure	* Average Time of Healing	Successful	Failure	Average Time of Healing	Successful	Failure	Average Time of Healing
Vertebra	1	1		1		101 days						
Rib	3	3		1		65 "	2		Unknown			
Scapula	1	1					1		54 days			
Humerus	16	15	2	9	1	99 "	4	/	64 "	1		32 days
Radius & Ulna	6	6		4		70 "	2		40 "			
Carpus	2	1	1	1	1	63 "						
Metacarpal	1	1		1		Unknown						
Phalangeal	2	2					2		33 "			
Ilium	3	2	1				2	1	72 "			
Ischium	2	1	1	1	1	171 days						
Femur	64	49	15	36	12	149 "	8	3	60 "	5		122 days
Tibia & Fibula **	25	20	5	17		133 "	2	4	46 "	1	1	
Tarsus	8	4	4	4	4	65 "						
Shoulder	2		2		2							
Elbow	3	3		3		85						
Wrist	1	1		1		100						
Hip	1		1		1							
Knee	2	1	1	1	1	87 "						
TOTAL	143	110	33	80	23	99	23	9	53 "	7	1	72 "

** In no case was the fibula alone involved.

* Many of these cases had plastic operation before healing occurred.

The zinc chloride method was employed in eight of our cases. The results can be seen by reference to Table 1. The number of cases in which it was employed are too few to draw definite conclusions. It is interesting to note that ultimate healing occurred in all but one case.

Fig. 1.—Illustrating extensive tunnel in shaft of the femur. A Dakin tube is shown in the sinus tract.

Fig. 2.—Same as Figure 1, two weeks later, illustrating the result obtained by effacement. Due to the splint, the plane of the picture differs from Figure 1.

We abandoned the method because our results were not superior to results obtained by other methods and therefore the additional risk entailed by use of this method did not seem justified.

POST-OPERATIVE TREATMENT.

At the conclusion of the operation the wound may be left open or it may be completely or partially closed. When it was left open we employed packs saturated with Dakin's solution or, introducing Carrel tubes, followed out Carrel-Dakin treatment. The latter caused the patient much less discomfort although ultimate time of healing was not materially affected. It was our custom in most cases to continue active Carrel-Dakin treatment until the wound was clean and no longer tender. Then daily dressings of dichloramine-T or Dakin's solution were substituted. Secondary closures were not particularly successful.

Fig. 3.—Same case as Figures 1 and 2, showing fracture occurring six weeks after operation.

Fig. 4.—Same case as Figures 1, 2 and 3, showing the result six months after fracture. The wound has been healed for two months.

It was our experience that secondary closures and cases allowed to *granulate from the bottom healed, leaving a sinus tract to close last. This leads us to do partial closures at the time of operation.* One or two rubber drainage tubes were placed at the most dependent part of the wound to provide free drainage. They were usually required for about ten days. After that, if required, the tract was Dakinized after the manner of treating empyema sinuses. The suture line was protected by vaseline strips. The part was firmly bandaged, using lots of cotton to obtain compression without shutting off the circulation. By this method the soft parts were pressed firmly into the effaced area. The first dressing was done on the second or, preferably, the third day. The dressing on the operating table was so applied that the dressing over the draining area could be changed without removing the compression dressing. When the method failed, stitches were removed, Carrel-Dakin treatment started and the wound allowed to granulate from the bottom. Nothing was lost by attempting partial suture.

FIG. 5.—Extensive osteomyelitis of lower part of femur with multiple tunnels. Leg was 2½ inches short. Amputation was performed.
FIG. 7.—Extensive destruction of head and neck of femur.

As can be seen from Table 1, an average of forty-six days in time of ultimate healing was saved the sixty-five per cent. of the cases in which the method succeeded. Another advantage was the excellent scar that resulted. Re-operation for adherent scars was not required in such cases, whereas forty-six plastic operations were required on cases that had been allowed to granulate from the bottom.

After operation, in addition to the management of the wound, other things require consideration. If the bone has been greatly weakened, a suitable splint is imperative. It is the writer's belief that all cases do better if splinted and elevated for at least two weeks on account of the rest it gives the part. Gentle massage is of value in maintaining muscle tone and improving the nutrition of the part. Physiological use, however, is the best method of obtaining these results and in addition is the best stimulus to bone regeneration. As soon as the discharge has lessened and the tenderness has disappeared, the patient should be encouraged to commence use of the part. If the bone has been much weakened, a properly fitted brace or caliper should be made and its use insisted upon.

FIG. 6.—Illustrates a hopeless case of extensive osteomyelitis of the tarsus.

UNHEALED CASES.

Cases that are still unhealed two years after receipt of their wounds were referred to above. The commonest causes of failure to obtain healing were active bone infection, improperly performed operations, unfavorable location, of the wound, low resistance of bone or part of bone involved, and great loss of substance of the soft tissues, in addition to bone injury. In certain cases, particularly where there has been extensive comminution of the bone at the time of the original fracture, the entire thickness of the bone is infected. At operation, therefore, removal of all diseased bone is frequently impossible. Such cases do best if laid wide open, sequestra removed, and any tunnel or cavity effaced, and then allowed to heal from the bottom. Attention to the general condition of the patient is very important. When healing cannot be obtained by these measures, resection or amputation would appear advisable. Unfortunately, the femur is the bone most frequently involved. Resection is impractical and amputation, in most cases, would have to be done so high that the patient will not consent. Not infrequently an area of bone infection, comparable to an ulcer, is found at the bottom of a sinus tract that refuses to heal. When sequestra or foreign body can be eliminated, curettement and Dakinization are all that is required to heal such cases. When operation is not properly performed, *i.e.*, sequestra or uneffaced cavities or tunnels allowed to remain, chronic sinuses or alternating periods of healing and draining result (Figure 1). Close to joints, as has been mentioned before, complete effacements are frequently impossible.

In such cases, large cavities may result that heal very slowly. Filling such cavities at secondary operation by muscle or fat flaps is the method of choice. Frequently, however, as in the cases referred to above, loss of substance and adherent skin prevents closure after the flap has been placed. The poor resistance of the spongy bone of the epiphysis and of the tarsus has already been considered. Extensive destruction of the soft parts usually requires a pedicle graft for closure. The writer has obtained excellent results on calf and heel defects by such flaps taken from the opposite thigh. Unfortunately, certain defects are so extensive or so located that such procedures are impossible. In such cases, when a good granulating surface is obtained, skin graft is the only method of closure. A permanently adherent scar which is likely to break down and ulcerate is the end-result in such cases. Amputation is the only other alternative.

COMPLICATIONS AND SEQUELAE.

Certain complications or sequelæ of chronic osteomyelitis frequently require treatment. Of these, refracture, erysipelas, abscess formation, and adherent painful scars deserve consideration. A consideration of the orthopædic deformities is beyond the scope of the present paper. Sixteen cases of refracture occurred in our series. The femur refractured thirteen times and the tibia three. In four cases, refracture occurred on the operating table. In the remaining twelve a fall or other trauma was responsible. Such fractures do well and union is the rule. There were two non-unions of the femur and in two other cases the fracture is too recent to judge the outcome. Refracture is particularly likely to occur where extensive effacement has been done or where angulation exists as the result of mal-union of the primary fracture. In the latter case, refracture permits correction of the deformity. Our cases are treated by Hodgen splint suspension in the Balkan frame until union occurs and then patient is allowed about with a walking caliper. Adhesive plaster traction in the Hodgen splint has been entirely satisfactory in our refractures. The tendency to deformity is less than in recent fracture. "Ice tong" traction is not required. The excellent results obtained in refracture are illustrated by Figures 2, 3, and 4.

Attacks of erysipelas may occur in healed or unhealed cases. They appear to be due to colonies of streptococci in wound or scar, that for some reason become active. Cases vary greatly in extent and severity. There were no deaths on our section, but in two cases transfusion was

required. No one particular treatment seemed to be more effective than others. Rest in bed, stimulating elimination, elevation of the part and any type of wet dressing were all that most cases required. Abscess formation occurred in cases with retained sequestra or foreign bodies or where uneffaced cavities or tunnels existed. As mentioned before, good drainage, to be followed later by the necessary bone operation, was found to be the most effective way to handle such cases.

Adherent scars are most frequent in cases allowed to granulate from the bottom. Such scars are frequently painful and limit motion of adjacent joints. The treatment is excision back to sound tissue and closure of muscle, fascia, and skin layers separately. In some cases pedicle flaps are required.

CONCLUSIONS.

1. Of 359 cases of chronic osteomyelitis following compound fracture, 33, or approximately 10 per cent., were unhealed after two years of hospital treatment.

2. Chronic osteomyelitis of spongy bone, *i.e.*, of the epiphysis of long bones, carpal and tarsal bones, is more difficult to cure than osteomyelitis of compact bone of the shafts.

3. Extensive tarsal involvement, where healing has not occurred within six months, requires amputation. The same applies to epiphyseal osteomyelitis, where resection is impractical.

4. Of the long bones, osteomyelitis of the femur is the most difficult to cure. 45 per cent. of unhealed cases were involvements of this bone.

5. Of the operative measures, careful effacements and partial closure gave the best and quickest results. The end-results of extensive effacements were excellent.

6. The employment of chemicals at time of operation is of secondary importance. Careful, thorough surgery is of first importance.

7. Plastic operations facilitate healing and are indicated for adherent scars or soft part defects.

8. Refraction is frequent in chronic osteomyelitis. The femur and tibia are most frequently fractured. Union is the rule. Non-union occurred only twice in fourteen such fractures.

NOTE ON A MALFORMATION OF THE CARPUS.

BY JAMES EAVES, M.D., AND PAUL CAMPICHE, M.D., SAN FRANCISCO, CALIFORNIA.

M. S., a laborer, 20 years old, came under our care on October 7, 1921, for an injury to his spine. In the course of the examination it was found that he had a malformation of both wrists and this was thought sufficiently rare to justify a short description of the condition.

This man tells the usual story of his mother having been frightened when she was pregnant. Five months before his birth the mother was looking through a window when she suddenly saw a man, whose legs had been amputated below the hips, walking on his hands. She was very much shocked at that sight. When he was born his parents noticed that there was something peculiar about the shape of his hands, but as he could move them very well in all directions they did not pay much attention to it and did not seek medical advice.

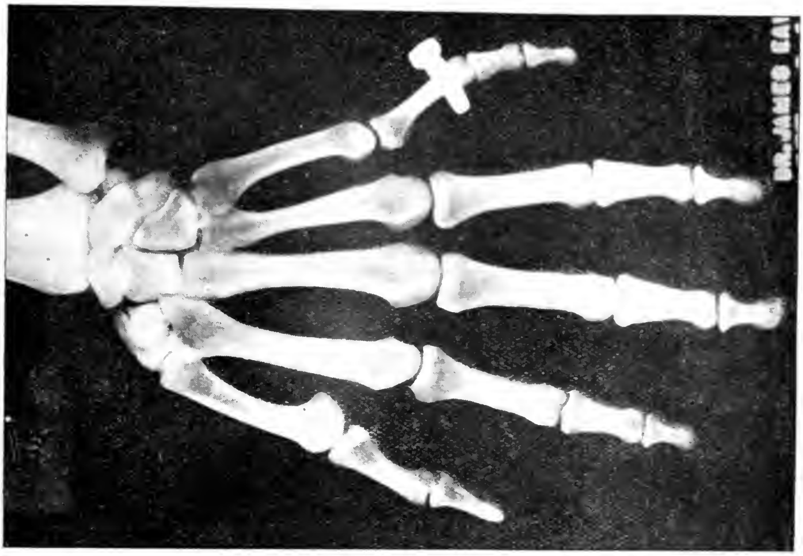
His present condition is as follows:

Left Hand: His left hand is rather small and the fifth finger is curved toward the radius. All the movements of the wrist are very extensive and especially the adduction of the hand, toward the radial side, is much greater than in a normal subject. The x-ray shows that the navicular is about one-half normal size and the styloid process of the radius is absent.

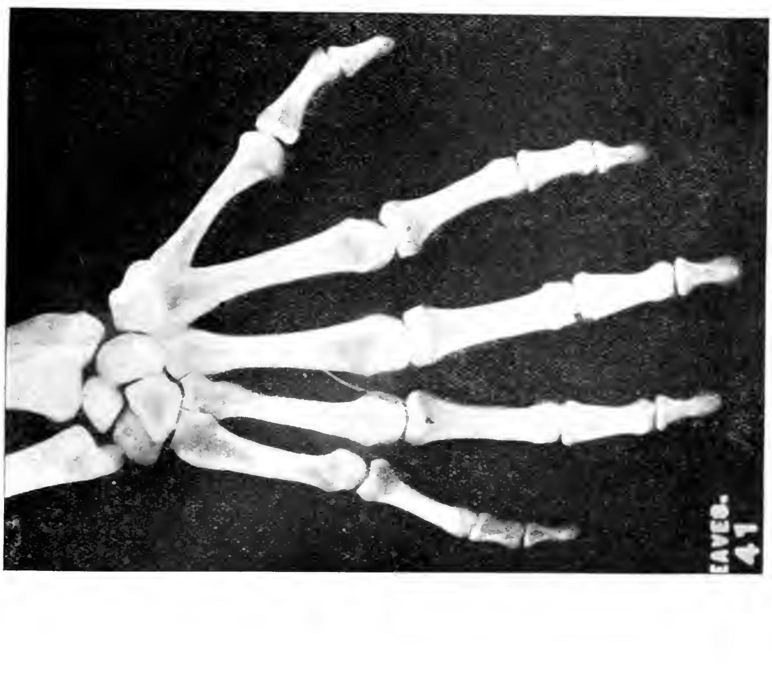
Right Hand: There is a marked prominence of the base of the first metatarsal toward the vola and the muscles of the thenar eminence are quite thin. The right thumb is small and markedly curved with a concavity toward the ulna; the right index finger is similarly curved, while the fifth finger shows a curve with concavity toward the radius. The lateral movement of the wrist towards the radial side is very extensive. The x-ray of the right wrist shows a total absence of the navicular and a poor development of the styloid process of the radius.

The patient himself is rather pleased with the extensive motion of his wrists and claims he can do many things at work that a man with normal hands could not do.

The radial pulse in both hands was found to be at the middle of the wrist. As to other defects, he also has a hypospadias which is not very bad and did not have to be operated upon. It was also noted



Left



Right

that he has an abnormal overgrowth of hair. A radiograph of the skull showed a small sella turcica, the anterior and posterior clinoid processes being in contact.

Isolated malformations or absence of carpal bones seem to be quite unusual; the only similar case that came to our notice is the one reported by F. Bähr.* All other cases seem to be complicated with severe malformations of the hand and forearm such as club-hand, absence of radius, etc., and were mostly found in young children, where the bones are not ossified and the cartilage does not always show the deformity in such a decisive manner. Therefore, we have reported this case not only for the sake of academic completeness, but also with a view to the difficulties of the differential diagnosis of some wrist injuries, especially in industrial accidents, as it is always convenient in such instances to have all known anomalies collected and catalogued in the text-books on the subject for reference and comparison.

FRACTURE OF THE SPINE.

BY S. KLEINBERG, M.D., F.A.C.S., NEW YORK CITY.

In the average orthopædic hospital, and in private practice as well, fracture of the spine is of comparatively rare occurrence, and the diagnosis is usually easy. This is so because the *history of the case*—generally revealing a condition of long standing; *the deformity,* caused by a compression fracture in which a considerable localized prominence or knuckle of the spine has developed; and *localized pain* makes the diagnosis evident. Among industrial injuries, on the other hand, fracture of the spine is of frequent occurrence, and its early recognition is at times very difficult. The difficulty arises from one or more of three very distinct causes: First, the lack of appreciation of the clinical symptom complex which indicates the existence of an injury to the spine. Second, the symptoms, both subjective and objective, may be so mild that they are readily explained by some simple injury, such as a contusion, or a sprain of the back. In fact they may

*Bähr, Ferd. Fortschritte auf dem Gebiet der Röntgenstrahlen 18 (1911-1912), p. 263. Ein Fall von Missbildung der Handwurzel.

be so mild that the patient himself does not pay any attention to them until they have lasted for many weeks, or even months. Third, some one symptom may be so prominent as to distract attention from the spine and suggest a condition other than injury to a vertebra.

It seems worth while, therefore, to consider briefly the clinical characteristics that go to make up the diagnostic symptom group. We assume that there is in every case a distinct history of an injury in which the back was subjected to direct or indirect violence.

CLINICAL CHARACTERISTICS.

(*A*) *Subjective Symptoms.*

1. The constant and characteristic symptom of fracture of the spine is definite, persistent, and localized pain in the back. This pain may vary in intensity from being so mild as to be overlooked by the patient for a long time, to being so severe as to confine the individual to bed, and to demand very large doses of morphine for its relief. As demonstrating this point I refer to the first case of my series in whom the pain was so mild that the patient practically paid no attention to it; while in another case, Fred H., the discomfort was so great that for weeks the patient was in bed, or at least confined to the house, with continuing agonizing distress, and required daily administration of several grains of morphine for relief.

2. The second important subjective symptom which leads us to suspect an injury to the vertebrae is persistent weakness of the back. Though apparently well, the patient is very much disinclined to any, even mild work. For instance, one sees a man who looks strong and sound, has a mild pain in the back, and states that he cannot lift a small chair. From the appearance of the individual it is evident that this weakness is not due to any constitutional condition, but is due to some painful condition aggravated by, and therefore inhibiting muscular effort.

3. The pain in the back, above noted, is aggravated by any and all motions of the spine.

4. Disability: This is proportionate to the pain, and accordingly varies from a very slight to an extreme degree. The patient may be able to go about with support, and perhaps even engage in some light work that involves the use of his hands only, or he may be so thoroughly disabled as to be confined to bed.

5. Referred Pains: These pains are complained of in the head, chest, abdomen, upper or lower limbs, and are referred to the dis-

tribution of the spinal nerves issuing from the spine in the vicinity of the injury. They are usually mild in degree, but persistent and continuous. Occasionally they are very distressing. They are important for two reasons: First, if properly interpreted, they indicate the source of the trouble, and localize the site of injury. For instance, pain in the lower abdomen refers to or suggests injury of the lower dorsal spine. Pain in the lower limbs suggests a lesion in the lumbar vertebrae, etc. Secondly, these pains are of particular interest, because, when they are marked and chance to be definitely localized, overshadowing other complaints, they are likely to be interpreted not as referred pains, referred from some injury to the spine, but as indicating some local lesion. For instance, in one of the patients of our series the two chief complaints were pain in the lower part of the abdomen, and persistent vomiting. Coupled with these symptoms were advanced age and marked anaemia, and the picture was suggestive of a malignant disease of the gastro-intestinal tract, rather than an injury to the spine. One must, therefore, be careful not to misinterpret referred pains which may obscure the real cause of the trouble.

6. Symptoms of cord involvement. Weakness of the limbs, unsteadiness in walking, paralysis and inability to walk, loss or disturbance of sensation, loss of control of the sphincters of the bladder and rectum, indicate injury to or pressure upon the spinal cord. According to Pearce Bailey the cord is injured in two-thirds of all cases of spinal fractures.

(*B*) *Objective Symptoms.*

1. Just as localized pain is the most common and characteristic of the subjective symptoms, so is definitely localized tenderness of the spine the most frequent and pathognomonic of the objective symptoms. While the tenderness may vary from being very mild to extremely marked, it is always present, and by its localization indicates the site of injury.

2. The next important objective finding is stiffness of the back, some limitation of motion of the spine in every direction in the neighborhood of the injury. It is important to recognize that the limitation is present in every direction, though of course not necessarily equal in all directions. This limited mobility indicates that the bodies, and therefore the adjacent regions of the inter-vertebral areas, have been disturbed. In an injury such as a sprain of the back that does not involve the bodies or the posterior arches of the vertebrae there may be limitation of motion of the spine, but that is usually not pres-

ent in every direction. There may be, for instance, limitation of lateral bending to the right, or limitation of flexion, while rotation or extension is entirely free. It is the fact that involvement of any part of the body or of the posterior arch of a vertebra causes limitation of motion in every direction, that the finding of restricted motion, in combination, of course, with the other physical signs, points very definitely to a lesion of the vertebra itself.

3. A definite change in the contour of the spine, when present, is an extremely important finding. Usually it appears either as a knuckle, that is, an increase in the posterior curvature of the spine, or as an area of localized flatness, thus causing a break in the normal physiological antero-posterior curvature of the spine.

4. A symptom less often found is limited and localized sensitiveness of the spine or pain in the back on indirect injury or pressure, such as is obtained by jarring the spine either through making the individual jump down on his heels, or by tapping him on the head.

5. Disability as shown by the stiffness of the back, inability to move freely, awkward or spastic walking, or paralysis of the limbs.

6. X-ray Examination: While we can be fairly certain, from the above study of the subjective and objective findings, of the nature of the injury, the most convincing evidence is found by radiographic examination. In a *clear* picture of the spine, the evidences of a fracture are so plain that they leave no room for argument or doubt. I have used the term "clear" advisedly, because in a hazy or indistinct picture the evidence may be concealed. It is, therefore, worth while emphasizing a few important points relative to x-ray examination.

The first and the most important point is the value of a lateral or oblique view. In the antero-posterior picture of the spine, we are looking at a flat impression in which are projected the shadows of the bodies, laminæ, the transverse processes, spinous processes, and the pedicles, so that it is possible, and it frequently happens, that an area or streak of increased penetration, indicating a line of fracture, is covered up by the shadow of the accessory parts of the vertebra. For this reason it is best to take a lateral or oblique view in which we get a separate shadow of the body of the vertebra. The anatomical radiographic appearance of the body of a vertebra in a lateral view appears rectangular, with the anterior border somewhat longer than the posterior border, and of even density throughout. In such a view reduction of the anterior border or of the vertical diameter of the body will indicate a crushing or compression fracture, while ir-

regularity of outline, distortion of the body, and lines of rarefaction or fracture become very evident and diagnostic. Moreover, the relationship between the different vertebrae, particularly those above and below the one injured, shows the position of the vertebrae as well as an injury to them, so that we may readily recognize, for instance, a fracture dislocation.

Secondly: An antero-posterior view is of value as it shows the relationship of the vertebrae to one another, and especially the size of the inter-vertebral discs. A diminution of the vertical diameter of one or more vertebrae, reduction of the corresponding inter-vertebral spaces and approximation of adjacent vertebrae indicate in a suspected case a compression fracture. In this view one can often recognize very distinctly a reduction of the vertical diameter of the vertebra and lateral displacement. One can also recognize injury, such as fracture and displacement of the transverse processes.

In studying the spine, therefore, it is necessary to take x-ray pictures in at least two planes, the antero-posterior, and either lateral or oblique. Stereoscopic pictures are helpful as they afford the opportunity of studying the relative position of the different fragments and are especially valuable in fracture dislocations. They are not, however, indispensable.

Thirdly: In order to get a clear x-ray it is necessary to empty the intestines of their contents as much as possible by means of catharsis and enemata.

Fourthly: To make sure that shadows of intestinal contents will not obscure the outlines of the vertebrae, it is well to use some means, as a rubber ball, for displacing the intestines from the spine during roentgenography. This is especially valuable in x-raying the lumbar vertebrae, which rarely give clear outlines. If the patient is turned on his side and a rubber ball is placed over the lateral abdominal region between the ribs and iliac crest and pressed down, the intestines will be displaced forward and a clear view of the lumbar vertebrae becomes possible.

SYMPTOM COMPLEX INDICATING FRACTURE OF THE SPINE.

The symptoms which, when found in combination, suggest a fracture of the spine are:

First: A history of an injury in which the back was subjected to a direct or an indirect violence

Secondly: Definitely localized and persistent pain in the spine, weakness of the back, referred or nerve root pains which indicate pressure upon the spinal nerves in the region of the localized pain, and cord symptoms such as sensory disturbances, spastic gait or motor paralysis.

Third: Localized tenderness of the spine, flatness or angulation of the spine, and limited mobility.

When these symptoms, all pointing to the same part of the spine, are present in an individual who previous to his accident was well, we can be reasonably sure that he is suffering from a fracture of the spine. X-ray examination is, of course, necessary to show the exact location, type and extent of the injury, but we should be able to make the diagnosis without it. This is especially important in the milder cases, where the patient looks well, and is able to walk about, and if the case is compensatable, the patient is likely to be considered a neurasthenic or a malingerer.

PROGNOSIS.

In the prognosis of a case of fracture of the spine we have the following conditions to consider:

1. The effect of the injury on the life of the patient.
2. The effect of the injury upon the spinal cord and spinal nerves.
3. The healing of the fracture.

1. Fracture of the spine *per se* does not threaten the life of the individual. The associated injuries, however, are often so serious as to cause the death of the patient. In cases of fracture of the spine with transverse lesions of the cord, cystitis may set in, bed sores appear and gradual exhaustion supervene as a result of the paralysis of the limbs, bladder, and rectum. These deplete the patient's energies so that an intercurrent affection rapidly claims the patient's life.

2. Nerve symptoms, such as sensory disturbances, weakness or paralysis of one or more limbs, paralysis of the bladder and rectum, result from injury to or pressure upon the spinal cord or spinal nerves. The nerve symptoms, as pointed out by Dr. Norman Sharpe, result from pressure of displaced fragments of vertebrae, edema of the cord or hemorrhage into the spinal canal. When the symptoms are due to destruction of the nerve tissue of the spinal cord, they are permanent. When they are due to pressure, they disappear when this pressure is relieved, unless it has been so severe or prolonged as to cause destruction of the nerves.

3. The healing of the fracture. In the average case of fracture of the spine, that is, a fracture with no nerve symptoms or very mild ones, the prognosis for ultimate recovery is very good. In fact, soon after the injury the patient is able to walk, even though that may be with some difficulty. These patients, even without treatment, may recover, but the symptoms usually last a long time, and recovery may come after considerable deformity and knuckling of the back has taken place. With treatment the outlook is particularly good, for we are enabled by efficient and prolonged support to prevent deformity, and ultimately hope for complete healing without disturbance of gait, and without serious impairment of the back. We must, however, recall that healing of a fractured vertebra is a very slow process, and consequently the period of disability, that is, the time elapsing between the date of injury and the time when the individual is able to return to work, is at least two years.

Regarding the function of the spine, it has been my experience that in most of the cases there results some degree of impairment and weakness of the back. These patients are seldom able to return to labors that require great strain of the back. They instinctively avoid lifting or carrying heavy weights.

The callus thrown out about a fractured vertebra is, compared with that appearing about other fractures, exceedingly small. Considering the associated structures, as the nerves in the vicinity of the vertebrae, it is well that this is so, otherwise the nerve disturbance from pressure would be serious and disabling. The healing then by callus formation is a very slow procedure, and is indicated by the disappearance of pain, tenderness, weakness, and ultimately of the disability.

TREATMENT.

The most important element in the treatment of a fractured spine is early and efficient support of the back. The support may be provided through an external splint as a spinal brace or plaster of Paris jacket, or through an internal splint by the insertion of a bone graft into the spinous processes of the injured and adjacent vertebrae. The plaster of Paris jacket is the usual form of splint employed. It is the most useful of the external splints because it can be applied at short notice, and when properly made acts as an efficient support. Such a support, changed every two or three months, should be continued for about two years.

When the support by jacket or brace is not sufficient, or when shortening of the period of convalescence is indicated, then the radical or operative treatment is employed. This aims at two things. First, to supply an internal splint by means of a bone graft inserted into the spinous processes of the injured and adjacent vertebrae. An internal splint naturally affords the spine more efficient support than a plaster jacket or a brace. Second, internal splinting hastens healing of the fracture through fusion of the vertebrae, and thus abbreviates the period of convalescence and disability. The operative treatment, through its evident advantages, would seem to be the treatment of choice. It is, but not as it has been practised in the past. We have been accustomed to resort to the insertion of a bone graft only after long delay with the conservative treatment. In this way a long time has already elapsed before we advise the bone graft fixation, and a statistical study may not show any gain of time from such an operation. If, however, the fractured spines were operated upon, let us say, within a month after the accident, we should, I believe, find rapid and early healing of the fracture, a great saving in time and reduction of the disability period.

Nevertheless, we should not forget that healing does take place under conservative treatment, and in instances where operation is contra-indicated we may feel confident that we will obtain healing of the fractured spine provided the splinting through brace or jacket is continuous, efficient, and prolonged.

There is, however, another phase to the consideration of the conservative versus the radical treatment of a fractured spine, and that is the difference in the resultant mobility and usefulness of the back. Under the conservative treatment the healing involves only the injured vertebra and those immediately adjacent to it, so that the stiffening of the spine is limited to the minimum number of vertebrae and the ultimate disability is therefore minimal. In the radical treatment there is deliberate operative fusion of at least six vertebrae, and the ultimate stiffening is, therefore, considerable. If the dorsal spine is affected, internal fixation is the most desirable form of treatment, because the dorsal spine normally has very little motion in it, and the stiffening resulting from the operation is not a detriment to the ultimate function of the spine. On the other hand, if the lesion affects only one vertebra in the cervical or lumbar region, the operative procedure directed to its relief promptly and forever completely immobilizes a part of the spine that is normally very mobile, and the re-

sultant disability, so far as the ultimate function of the spine is concerned, is serious. Furthermore, in view of the fact that these fractures, in the large majority of instances, affect laborers, to whom free mobility of the spine is of great moment, it is a very serious problem to decide as to the advisability of completely stiffening a mobile part of the spine, for the gain in time may not be commensurate with the ultimate results.

As for the duration of the convalescent period, under the conservative treatment the period of convalescence is about two years. Following an operation for a fractured spine, the period of convalescence, under the most favorable condition, would be between six and nine months. The gain in time of about six months to a year, while apparently a great advantage, does not appear of such tremendous importance when one compares the ultimate results; namely, from conservative treatment, complete healing with only a limited amount of stiffness of the back, and from operative treatment, earlier union but complete immobility of a large part of the spine.

Fracture of the spine with cord symptoms. When a fracture is complicated by cord symptoms, such as paralysis, the question of early laminectomy for relief of pressure arises. Motor and sensory nerve disturbances indicate injury to or disturbance of the spinal cord. These symptoms are the result of injury to or pressure upon the cord from displaced fragments of bone, edema of the cord or hemorrhage into or about the cord. From the symptoms alone it is impossible to tell, in the majority of cases, the nature and extent of the injury to the cord. In an occasional case the x-ray and clinical examinations make it reasonably certain that there is marked dislocation of a vertebra or fragment of bone with kinking of the cord. In such an instance laminectomy for relief of pressure is indicated. In the majority of the cases, however, the x-ray appearance is not an index of the degree of damage to or pressure upon the cord. The author has seen a case of extensively comminuted fracture of a vertebra with marked displacement of fragments in which the nerve symptoms disappeared within forty-eight hours under the usual supportive treatment. In this connection it is well to remember what Dr. Henry K. Pancoast says in speaking of the roentgen examination of the injured spine. He states that "In some of the most severe injuries to the cord there is often comparatively little roentgenographic evidence of traumatism to the spine, while, on the other hand, there may be a very serious fracture with permanent dislocation and marked displacement with little or no cord disturbance."

The matter would be simplified if we could determine in a given case whether the nerve symptoms were due to pressure from displaced bone fragments, kinking of the cord, hemorrhage, or edema of the cord. For with the exact pathology known, it would be easier to decide upon the proper course of treatment to pursue. This, however, is not possible. On the other hand, experience has shown that in many cases the nerve symptoms diminish or disappear spontaneously within a period varying from a few hours to a few days. Sometimes the nerve symptoms persist for months and then, especially if the spine is supported, diminish or disappear. The relief is presumably due to the absorption of blood, disappearance of edema or accommodation of the cord to its new position. In those cases in which the nerve symptoms do not disappear, there is destruction of nerve tissue sustained at the time of injury or caused by the ensuing pressure. Regarding the latter point Dr. Norman Sharpe observes that severe compression of cord fibres, either by bone, hemorrhage or edema, for a period of four days only, will result not only in the destruction of the injured fibres but in the permanent impairment of sound fibres. Hence waiting several days to see what recovery will ensue, may cause more severe impairment of the cord than that caused by the original injury.

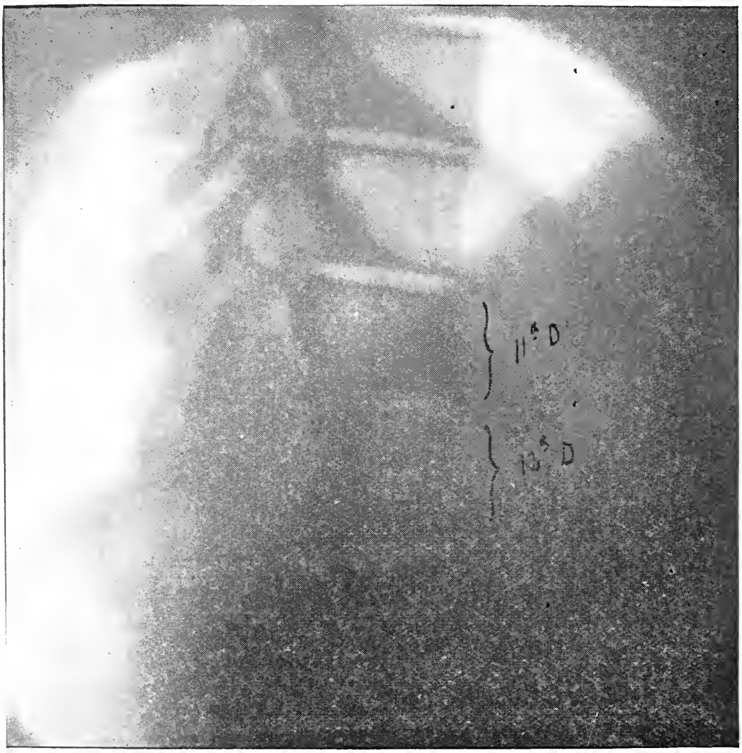
We have, however, at present no means of knowing in any given case of fracture of the spine, with injury to the cord, whether the nerve symptoms are due to irreparable damage, a removable obstruction, or to conditions which will be relieved by conservative treatment. Hence many surgeons believe that the only safe procedure is early laminectomy, as soon after the injury as the patient can stand the operation, to relieve pressure from the cord.

To this advice there are three objections: (1) The motor and sensory symptoms disappear in many cases under conservative treatment—*i.e.*, rest and immobilization. (2) Decompression laminectomy is often not followed by relief of the motor and sensory disturbances. In some cases the improvement occurs so late after the operation as to make it doubtful if the improvement is due to the operation. (3) The reported mortality from decompression laminectomy for fracture of the spine is very large.

In view of these facts, it is difficult to advise laminectomy in fractures of the spine, with nerve symptoms, without waiting a few days to observe the effects of rest and efficient support.

CASE REPORTS.

CASE 1. James F. Age 43 years. Laborer. He was injured September 27th, 1918; came under my care January 7, 1919. His chief complaint was pain in the lower part of his back, weakness of the back and pain in the back of his legs. His symptoms were very mild. He felt that he was just a bit weak as a result of his injury, he would soon be better, and resented having been sent to me for advice and treatment.



CASE 1.—James F. Compression fracture of 11th and 12th dorsal vertebrae.

His history revealed that he fell off a truck, a distance of a few feet, and struck his back. He got up and *walked* to the dressing station, a distance of a hundred yards. I mention this fact to show how mild may be the immediate effects, and how few the nerve symptoms. He was given some medication and went home. The pain in his back persisted and he went to a hospital where he stayed three weeks and then *walked home.* The backache continued, and three months after his accident I was consulted.

Examination showed that the patient was in excellent general condition. He showed no signs of suffering. His back appeared symmetrical and normal. There was mild but definite tenderness of the spine limited to the dorso-lumbar junction. Extension, lateral bending, and twisting of the spine were normal. Jarring the spine, as in jumping, caused pain in the lower part of the dorsal region. Neurological examination was negative, except for slightly overactive knee-jerks. X-ray pictures showed in the antero-posterior view a reduction in the size and thickness of the intervertebral cartilage between the 11th and 12th dorsal vertebrae. The lateral view showed a reduction of the vertical diameter of the bodies of the 11th and 12th dorsal vertebrae. This case was therefore one of compression fracture of the 11th and 12th dorsal vertebrae.

The x-ray evidence is, of course, diagnostic. The diagnosis is further borne out by the history of injury, the localized pain and tenderness and the restricted flexion of the spine.

The chief points of interest in this case are:

1. The persistent backache.
2. Localized tenderness of the dorso-lumbar junction.
3. Limitation of flexion.
4. Characteristic x-ray.
5. Mildness of subjective symptoms.
6. Absence of sensory and motor disturbances.

At the present writing (March 1, 1920), after practically fifteen months of continuous splinting, the fracture is not entirely healed, and there is still pain, tenderness, and weakness of his back. The disability has now existed for one year and a half and will probably last at least six months more, and possibly longer.

CASE 2. Jack J.: 46 years old. He was injured on August 27, 1918, and came under my observation November 2, 1918. His chief complaint was pain in the middle of his back, aggravated by walking and jarring of any kind. He complained also of a persistent pain on both sides of the chest at the lower costal border in the axillary line. He had in addition marked weakness of his back so that he was unable to lift objects. In the erect position he had practically no pain.

The cause of the injury and its history up to the time he consulted me are as follows:

A plank struck him on the back of his neck and threw him down. This was a fracture from an indirect injury to the spine, causing a sudden forced flexion of the spine and crushing of the vertebrae. He was taken to a hospital where he stayed two weeks. During this time he suffered a great deal of pain in his back and abdomen, but had no other difficulty. The pain was severe and continuous, preventing him from sleeping.

At the end of the two weeks he was told at the hospital that there was nothing broken and was discharged. He walked home and has

CASE 2.—Jack J. Compression fracture of 8th dorsal vertebra.

walked around since. The backache and disability have persisted, the backache getting worse.

Examination shows that the man is in good general condition. He dresses and undresses and moves about with apparently no discomfort. He sits down and gets up without difficulty. The back is symmetrical. The spine appears normal except for a moderate increase in the backward curve of the dorsal region. There is no angulation of the spine in either the lateral or antero-posterior directions. Palpation reveals marked tenderness of the spine opposite the angles of the scapulae. Elsewhere the spine is not tender. Flexion of the spine is limited to about one-half of its normal range, and is accompanied by pain in the dorso-lumbar junction. The other motions of the spine are also limited slightly and are accompanied by pain. All the deep and superficial reflexes are present and normal and there are no signs of motor or sensory disturbances. X-ray examination shows a very marked reduction of the vertical diameter of the body of the eighth dorsal vertebra—a crushing fracture. The intervertebral spaces between the 7th and 8th, and between the 8th and 9th dorsal vertebrae are markedly reduced.

The chief features of this case are:

1. An injury in which there was forced flexion of the spine.
2. Immediate localized pain.
3. Persistence of pain and disability.
4. Localized tenderness.
5. Absence of neurological symptoms.
6. Typical and diagnostic x-ray picture.

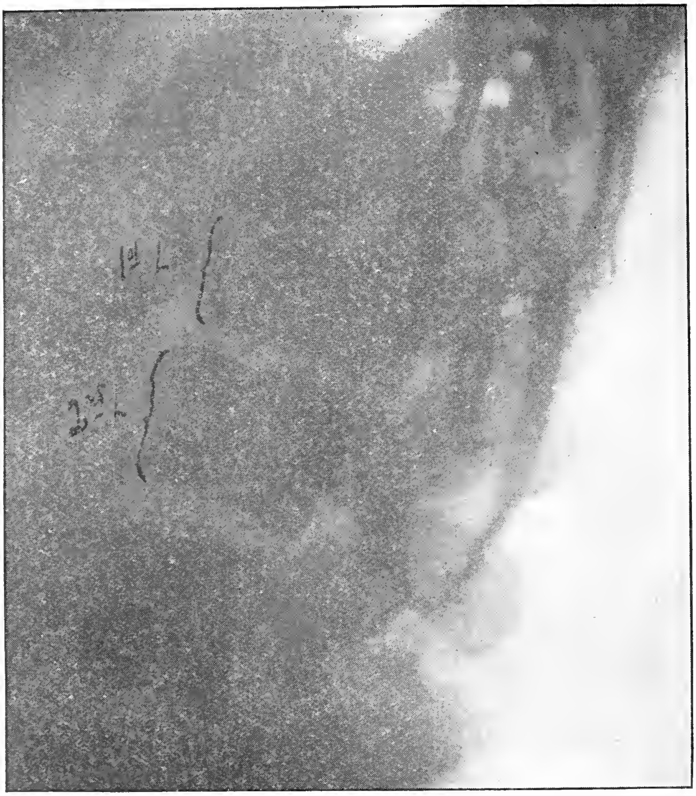
It is interesting here to note that this patient was in a hospital for several weeks and the condition not recognized. This was, of course, due to the fact that either x-ray pictures were not taken, or perhaps were taken but were hazy and did not show clearly. The history and type of injury, and the localized tenderness, should have suggested the diagnosis.

Following my examination I made a tentative diagnosis of fracture of the spine and sent him for an x-ray. The pictures and the report came back as negative. When I looked at the plates, it was evident that they were, for they were indistinct. I then sent the man back to the laboratory with the note that he had a fracture of the spine and that the plate ought to demonstrate it. The second series of pictures showed the condition unmistakably. I mention this detail to emphasize the point again that the pictures must be clear, and that they must be carefully examined. This is especially true if the pictures are by chance not very clear, or if the crushing of the vertebrae is not extensive.

Case 3. George H.: 37 years old. He was injured on September 14, 1918, and came under my observation December 10, 1913.

The chief complaint of this patient was pain in the lower part of his back and weakness of his legs. History: He was injured on the fourteenth of September, 1918, by a a bag of flour falling on the back of his head and throwing him to the ground. When he got up he found that he had severe pain in his back and he went home. The following day he was admitted to a hospital where they told him he had a sprain of the back and ought to rest in bed a few days. While in bed he had no discomfort. At the end of a week he got out of bed and found that his pain recurred. X-ray examination was then made and the first and second lumbar vertebrae found fractured. A plaster of Paris jacket was applied and worn for about six weeks. During this time his discomfort became greatly reduced. The jacket was then removed and he was allowed to go about without support. Since then the pain in his back returned and his gait became progressively more unsteady.

Examination showed that the man was in good general condition. He can walk without support but his gait is distinctly spastic and he holds his back rigid. He has difficulty in turning around rapidly, and when his eyes are closed, sways, is unsteady, and barely manages to take a few steps without support. He is moderately round shouldered, with slight increase of the posterior curvature of the dorsal spine. This is especially marked in the lower half of the dorsal region. The right side of the dorso-lumbar region is more prominent



CASE 3.—George H. Compression fracture of 1st and 2nd lumbar vertebrae.

than the left and there is a slight deviation of the spine to the right in this location, extending from the mid-dorsal to the mid-lumbar sections. *The entire lumbar spine is very tender, especially the first lumbar vertebra.* The lumbar spine is practically entirely rigid, with just a little lateral bending in either direction. Twisting, too, is almost entirely restricted. His knee jerks are overactive. His gait is unsteady and spastic, otherwise neurological examination is negative. X-ray examination, especially the lateral view, shows very marked reduction of the perpendicular diameter of the bodies of the first and second lumbar vertebrae. The intervertebral space between the 1st and 2nd lumbar vertebrae is greatly reduced.

The interesting features of this case are:

1. The typical combination of findings, namely, an injury, immediate localized pain in the back, persisting for months, localized tenderness, characteristic x-ray findings.

2. The diagnosis was not made soon after the injury because the condition was not suspected, and x-rays were not made until some time after the injury when it was evident that some organic lesion was present.

3. The reduction of the symptoms soon after the application of the first plaster jacket, its early removal and the reappearance of symptoms.

4. Spastic gait indicating pressure on nerve tissue as a result of the fracture.

This patient was in a plaster support continually from December, 1918, to August, 1919. He has at present no pain in his back, and his gait is normal. The knee jerks now react normally.

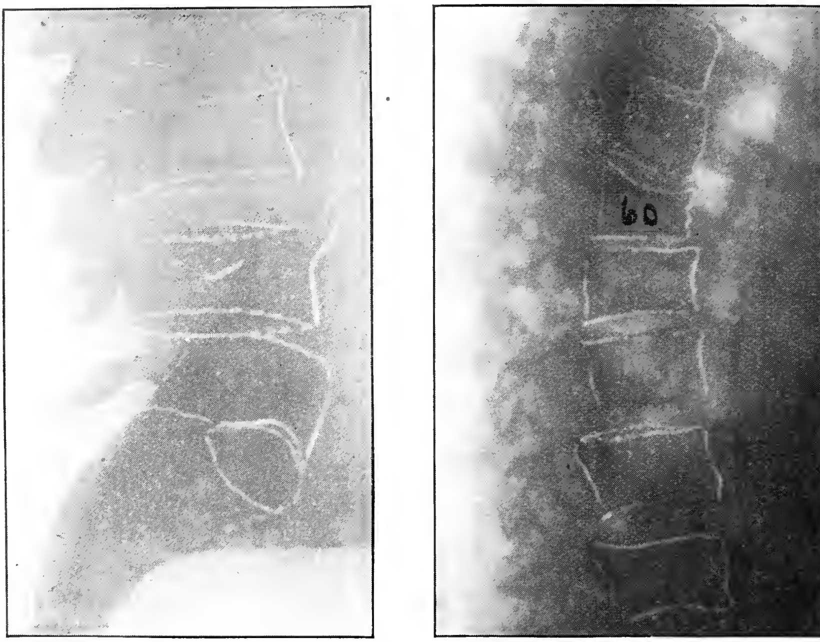
Case 4. Leopold B.: 47 years old. He was injured on February 13, 1918, and came under my observation November 18, 1918. His chief complaint was persistent pain in the abdomen, the upper and lower parts of his back, and vomiting after taking solid food. The vomiting was very distressing. He ate very little and appeared greatly emaciated. He mentioned his backache incidentally, laying emphasis only on his abdominal pain and vomiting. This was a "compensation" case and it was important to decide whether he had a condition the result of an injury, and therefore compensatable, or whether his distress was due to some other lesion in no way related to his injury, and for which the insurance company could not be held responsible.

On first appearance, the cachexia, vomiting, abdominal pain, and his age, suggested some malignant disease of his gastro-intestinal tract. Still, he did have an injury and did have some backache that needed investigation. He had gone for nine months without a diagnosis being made.

History: The patient was digging in a ditch, when the walls caved in; he was struck on his back and was doubled up. He became unconscious, remaining so for three hours. He was taken to a hospital and when he came to he had pain in his back, abdomen, and groins. He was kept in bed six days, and two days later was able to walk about and was discharged from the hospital. His pain persisted and during the next two months he received adhesive strappings to his back and some internal medication, and after that he was considered a neurotic, with some digestive disturbance.

Examination: When I first saw him he was in poor condition. He wore an abdominal belt and adhesive strappings on his back. He walked without support and undressed without difficulty. His gait was somewhat slow and awkward and he presented a noticeable degree of round shoulders. He held his back somewhat rigid and there was a transverse crease across the abdomen about 1½ inches above the umbilicus. The crease across the abdomen was very significant as it usually indicates some lesion of the spine. The explanation of this crease is that the lesion of the spine gives rise to a protective spasm of the muscles on the front and back of the spine, holding the spine and trunk

somewhat flexed. When this sign is present there is always limitation of extension. In the aged, who frequently have a senile osteoarthritis of the spine, this sign means only that the spine is limited in motion. In all other individuals it signifies some, usually important, lesion, as inflammation, injury or disease of the spine. This sign is seen in young adults with spondylitis deformities, in cases of Pott's disease, in fracture of the spine with posterior angulation—in fact, in any condition in which there is marked increase of the posterior curve of the spine.



CASE 4.—Leopold B. Compression fracture of the 5th lumbar vertebra and fracture-dislocation of 6th dorsal vertebra.

Back: There is a well-marked increase of the backward curve of the dorsal region of the spine and flatness of the lumbar region. The spine is deviated to the left in the dorsal region, and to the right in the lumbar region. This curve is mild and not accompanied by any appreciable rotation deformity. The spine is very tender in two areas: one, over the upper dorsal region from the third to the sixth dorsal vertebrae; second, over the lumbo-sacral junction.

The abdomen is normal in outline. The lower part is tender, but there is no rigidity and there are no palpable masses.

The deep reflexes are present and normal—neurological examination is otherwise negative.

X-ray examination of the gastro-intestinal tract suggests adhesions in the ileo-caecal region, and there is evidence of marked gastric and colonic hypomotility.

X-ray examination of the spine shows two lesions. There is a lesion involving the 4th, 5th, and 6th dorsal vertebrae. The intervertebral spaces between these vertebrae are practically obliterated. The body of the sixth dorsal is smaller than normal and displaced slightly to the right. The lesion here is, therefore, a fracture-dislocation of the sixth dorsal vertebra. The second lesion is at the fifth lumbar. This bone is compressed; a small fragment of bone projects from the upper surface of the body. The lesion in the spine is a fracture-dislocation of the sixth dorsal and a fracture of the fifth lumbar vertebrae.

Examination of the blood, urine, and feces is negative.

On account of the evident lesion of the spine, the other conditions, namely, the abdominal pain and vomiting, and hypomotility of the stomach and colon, were disregarded. A plaster of Paris Calot jacket was applied. Almost immediately the pain in the back and abdomen disappeared. His vomiting ceased and he again was able to take solid food. His improvement has continued and at the present writing (March, 1920) he appears in good condition, the pain in the dorsal region has entirely disappeared and h eis walking about comfortably, with a Taylor spinal brace.

This case presents several interesting points:

1. The diagnosis of fracture of the spine was not made until nine months after the injury.

2. The abdominal pain and vomiting, radicular or referred pains. were so prominent that they overshadowed the pain in his back, and suggested some abdominal condition.

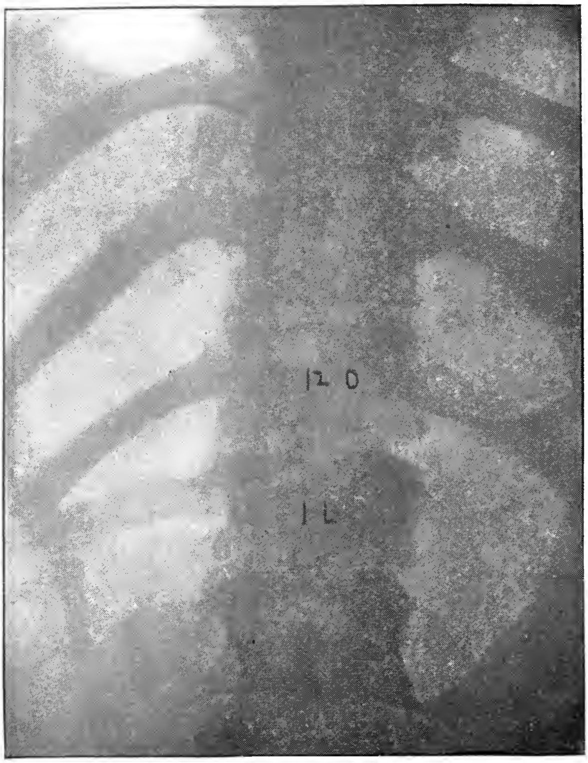
3. A double lesion of the spine.

4. Relief of the abdominal symptoms by the application of an appropriate support to the back.

Case 5. Harry W.: 22 years old. Window cleaner. He was injured on October 26, 1918, and came under my observation November 18, 1918. His chief complaint was persistent pain in the middle of his back, and weakness. He walked with some difficulty but that was, at least in part, due to an injury of the left knee.

History: He fell out of a third story window. There is no information obtainable as to how he struck the ground. He was picked up unconscious and taken to a hospital. When he regained consciousness, he felt severe pain in his back. For eight days he was on a water mattress. One week later he was able to walk around.

Examination: Patient's general condition is good. He walks awkwardly, but without support. He holds his back stiff. His back is symmetrical. The spine is in the median line. There is an area of flatness in the spine from the 8th to the 12th dorsal spinous processes. This part of the spine is very tender. There is also some tenderness of both lateral muscular areas of the dorso-lumbar junction. All the motions of the spine are markedly restricted. Jarring of the spine, as in jumping, causes severe pain in the dorso-lumbar junction. All reflexes are present and normal.



CASE 5.—Harry W. Compression fracture of 12th dorsal and 1st lumbar vertebrae. Note reduction in perpendicular diameter of affected vertebral bodies.

A series of x-ray pictures taken by one radiographer was reported as negative. The pictures were hazy and no diagnosis could have, or should have, been made. The clinical examination pointed to an injury of the spine, and a second series of pictures was taken. These showed a compression fracture of the 12th dorsal and 1st lumbar vertebrae. There was also a fracture of the right transverse process of the 1st lumbar vertebra. The failure of the first radiographer indicates the importance of obtaining clear x-ray pictures.

The principal points of interest in this case are:

1. The persistent localized pain in the back.
2. Tenderness limited to the painful region.
3. Characteristic and unmistakable x-ray pictures.
4. Failure at first to recognize the condition because of poor x-ray pictures.

Case 6. Frederick H.: 42 years old. Boiler-maker. Was injured in July, 1918, and came under my observation December, 1918. His chief complaint is persistent and severe pain in the lower part of his back. The pain is continuous so that he has no rest, night or day. The history obtained was as follows:

He was struck on his back by a sledge hammer. He had some pain in his back. After that he continued to work for an hour or so, and went home. During the following month he had pain in his back, but it was not so severe as to prevent him from working, which he did. The pain, however, became worse and he had to give up work. The pain has been so severe and constant that he has been getting increasingly more miserable, has lost a great deal of weight, and acquired a sallow complexion.

Examination showed the patient was of good muscular build. He is evidently in pain, shifting about from one position to another. He walks awkwardly, and at all times holds his back rigid and seeks support, although he can walk without help. The back appears symmetrical. There are no abnormal prominences or depressions on either side of his spine. The spine is in the median line, with no lateral deviation in either direction at any part of it. At the lumbo-sacral junction there is a transverse fold of skin, immediately above which there is a depression, at which point the spine appears to sink forward. At this junction the spine is very tender; elsewhere along the spine there is no tenderness. Lateral compression of the pelvis causes pain in the lumbo-sacral junction. All motions of the spine are markedly, almost completely restricted, and attempted motion of the spine causes severe pain. All reflexes are present and normal.

X-ray examination shows a comminuted fracture of the 5th lumbar vertebra. There is a loss of the usual rectangular outline of the body of the 5th lumbar vertebra. The body of this vertebra is divided by a line of fracture into front and posterior halves. The posterior half is crushed, and there is a small, loose fragment next to the under surface. The upper surface of the posterior half appears united to the 4th lumbar vertebra. The front half of the injured vertebra is attached to the posterior half in the upper portion only, while there is a wide interval between the front and the posterior halves in the lower part. The front half of the vertebral body has slipped somewhat forward, overlapping the sacrum. The antero-posterior view of the spine shows a loss of the normal outline of the 5th lumbar vertebra in the region of the right articular process. There is a transverse black line indicating a fracture, and there are several dense spots, indicating new bone formation. The intervertebral space between the 4th and 5th lumbar vertebræ is practically obliterated.

On account of the heavy build of this patient we had great difficulty in getting x-ray pictures that were sufficiently clear to indicate beyond a doubt the existence of a fracture. The type of injury, and the transverse fold of skin at the lumbo-sacral junction, plus the sinking in of the spine at that spot, suggested a traumatic spondylolisthesis.

CASE 6.—Fred H. Comminuted fracture of 5th lumbar vertebra. Fracture of spinous processes of 4th and 5th lumbar. Note irregular shape of body of 5th lumbar.

The chief points of interest in this case, therefore, are:

1. A comminuted fracture of the 5th lumbar vertebra as the result of a direct blow.
2. Difficulty in identifying the fracture because of the difficulty in getting clear x-ray pictures of the lumbo-sacral junction.
3. Pain and disability which for one month following the injury was so slight that the patient was able to work, finally becoming so severe that the patient had to be given morphine in large doses for many weeks, until fixation, by means of an Albee bone graft, completely relieved the patient.

This patient was treated at first, as the others of this series, by a plaster jacket. This gave no relief and was replaced by a plaster jacket-spica. This splint gave no relief and finally, after about six weeks of splinting with plaster, he was operated upon and a bone graft inserted into the lower lumbar and upper sacral spinous processes. He was kept in bed for six weeks, after which he was allowed to get up,

wearing a Knight spinal brace. His pain disappeared a few days after the operation, and eight weeks later he was able to walk about comfortably without any other support than the brace.

CASE 7. Mary M.: 55 years old. Housewife. Came under my care, February 14, 1920. She was injured nine weeks ago. Her chief complaint was pain in the middle of her back. The history reveals that she fell while walking, striking her back, but she does not know what position she was in at the time her back was injured.

The injury was not considered serious and she had an adhesive plaster strapping applied to her back and was permitted to walk about. The pain continued and she was advised to have an x-ray picture taken of her sacro-iliac joints. This picture was negative and she was finally referred to me with a diagnosis of some indefinite lesion of her sacro-iliac joints.

Examination showed that the patient was in good general condition, walked very awkwardly, stooping forward, with a very distinct increase in the posterior curve of her spine. The patient experienced considerable discomfort in undressing and stated that she had difficulty in finding a comfortable position to lie in. Lying on her face was exceedingly uncomfortable. She pointed to the dorso-lumbar region as the site of her severest pain.

Examination of the back shows that it is symmetrical and the spine is in the median line. There is a very distinct knuckle or posterior angulation of the spine at the dorso-lumbar junction. Palpation reveals very marked tenderness at the dorso-lumbar junction but at no other part of the spine. There is a transverse crease across the upper part of the abdomen, such as we often see with backward angulation of the spine. Hyperextension is entirely limited, while flexion and lateral bending in either direction are limited to about ½ of the normal range. All the motions of the spine are painful. The rest of the back and both sacro-iliac joints are negative. Both knee jerks are exaggerated. There are no sensory disturbances.

The combination of an injury, and definitely localized pain and tenderness at the dorso-lumbar junction, limited mobility and angulation of the spine made it evident that the patient was suffering from an injury to the spine.

X-ray examination of the spine shows a compression fracture of the first lumbar vertebra. The body of this vertebra is compressed to about two-thirds of its normal extent.

The chief points of interest in this case are:

1. Persistent localized pain in the dorso-lumbar region of the spine.
2. Localized tenderness at the dorso-lumbar junction.
3. Limitation of the motions of the spine.
4. Characteristic x-ray.

CASE 7.—Mary M. Compression fracture of 1st lumbar vertebra.

5. Absence of sensory and motor disturbances.
6. The diagnosis was not made until nine weeks after the injury, although during this entire time the patient was under the care of a physician.

CASE 8. Frank De P.: 52 years old. Laborer. Came under my care September 4, 1918. He was injured July 30, 1917. The chief complaint of this patient was persistent pain of the lower part of his back, aggravated by all motions. Jarring of any kind aggravated the pain and he has become exceedingly nervous.

The history reveals that on July 30, 1917, he fell a distance of 40 feet. Following the injury he was unable to walk. He was carried home and kept in bed for about four months. Subsequently, he gradually got about so that at present he is able to walk without assistance.

Examination on September 4, 1918, shows that the patient is in excellent general condition. Walks about without external support and undresses without any help. He stands erect and walks with his body

in the normal, upright position. In sitting down, he does so very guardedly as if afraid of pain.

Back: The back is symmetrical. The spine is in the median line and there is no lateral deviation in either direction, or change in the antero-posterior curve of the spine. There is marked tenderness of the spine, limited to the dorso-lumbar junction. All motions of the spine are limited and painful.

X-ray examination shows a diminution of the vertical diameter of the first lumbar vertebra, but no lateral displacement. This patient evidently has a compression fracture of the first lumbar vertebra. A Knight spinal brace was fitted to the back, with the spine in hyperextension. This was worn continuously until February 6, 1920, when I examined and x-rayed the patient again. At this date there was a very distinct knuckling at the dorso-lumbar junction, but complete absence of tenderness of the spine at the site of injury.

In order to determine the condition of his back, the patient was admitted to the Hospital for Ruptured and Crippled, for observation, and was advised to go about without his brace for a few days. It was then found that he walked about without his brace without any discomfort.

X-ray examination shows that the body of the first lumbar vertebra is reduced to about two-thirds of its normal diameter. The intervertebral space between the first and second lumbar vertebrae is diminished in size and is very hazy in several places, indicating what appears to be bony fusion of the first and second lumbar vertebrae. In the antero-posterior view the union between the first and second lumbar vertebrae is shown by lateral bars of bone joining the two vertebrae.

The absence of tenderness and pain at the site of injury and the x-ray evidence of bony fusion of the first and second lumbar vertebrae, indicate that in this case there has been complete healing of the fracture.

The interesting features of this case are:

1. The typical group of symptoms of fracture of the spine, namely, an injury to the back, localized pain, localized tenderness, limited mobility, and a characteristic x-ray picture.

2. The diagnosis was not made until fourteen months after the injury.

3. Complete healing of the fracture under conservative supportive treatment.

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ON DELAYED UNION AND NON-UNION OF FRACTURES.

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Fractures fortunately have a marked tendency to unite even when the so-called "setting" has been left to nature alone. In spite of this benign tendency, much study has of late been bestowed on the question of difficult union. There has been so much confusion, even up to the present time, in differentiating between delayed union and non-union or failure of union that it may be well to emphasize the difference between them. Sir Robert Jones insists that it is at times difficult to distinguish between the two conditions.

By delayed union is meant a retardation of the process of normal bony consolidation of a fracture. For example, we speak of delayed union when a femur fracture is examined eight or ten weeks after the break occurred and the bones are found not yet united. The fact that union is not yet present by no means implies that it can never occur, and hence this delay in union is to be sharply distinguished from non-union. Delayed union is fairly common, while non-union is rather rare. If after exhausting all means to promote union, short of operation, faithfully and for many months, the bones still refuse to unite, one is justified in diagnosing non-union. By this is meant that the bones can never be expected to unite in their present condition, and that but one resource is left to secure consolidation, namely, to operate. Delayed union means retardation for one cause or an-

other of the process of callus formation, while non-union is a more serious condition and implies that consolidation is no longer to be hoped for, save by operative means. If a time limit is to be placed, one may consider delayed union as existing, speaking very broadly, up to from six to twelve months following the accident. After this lapse of time one may consider the case as one of non-union rather than delayed union. From another view-point delayed union in general means non-operative treatment with good hope of success, while non-union implies operation of necessity.

FREQUENCY.

Stimson, quoting von Bruns, whose fracture statistics are based on an enormous number of cases, gives delayed union in one and one-quarter per cent. of fractured limbs, with non-union occurring in only one-half of one per cent. Stanley Boyd, in Treves's "System of Surgery," gives delayed union in one and one-fifth per cent. of cases. Mr. Hey Groves, the editor of the *British Journal of Surgery*, speaking in May, 1919, at Atlantic City before the American Orthopedic Association, estimated that from four to five per cent. of his fractures showed non-union. He did not give statistics on delayed union. Hunkin says that fractures generally unite in ninety-five per cent. of cases. Members of the Canadian Army Medical Corps with extensive overseas experience emphasize the comparative rarity of non-union, and, without producing statistics, are inclined to the view that Mr. Groves' figures are too high. Von Bruns' and Boyd's percentages they consider too low. In their opinion the truth lies between these two extremes, and non-union may be considered to exist in about two to three per cent. of all fractures. With the exception that in elderly subjects consolidation is apt to be delayed, age seems to play but a small part in determining difficult union. Some bones when fractured appear to have a predisposition to delayed and non-union. Robert Jones emphasizes the additional risk of non-union incurred in fractures of the middle third of the femur, in the humerus between the middle and upper thirds, and in fractures of the lower third of the tibia and fibula. The bones of the forearm, as a rule, give little trouble in uniting, with one notable exception. This exception, which should also be considered as applying to fractures of the lower leg, has reference to cases where extensive loss of substance exists in one of paired bones. Fractures of the neck of the femur fail to unite with relatively great frequency.

CAUSES OF DELAYED AND NON-UNION.

These may be considered under the heading of general and local causes. By a general (or constitutional) cause is meant that retardation of union is being brought about indirectly by the systemic effect of some infection or dyscrasia. Under the heading of general causes may be found almost every known malady. The importance of them all, with the probable exception of syphilis, is largely academic, and it is to be emphasized that local causes play a vastly greater rôle. With regard to syphilis it is interesting to note the experience of members of the Canadian Army Medical Corps. A substantial proportion of cases of delayed and non-union seen at the Buxton Hospital were found to be syphilitic (Tees), and responded favorably to anti-luetic medication. The presence of syphilis should therefore be without doubt suspected in treating cases of delayed and non-union. An interesting question arises at this point. Syphilis has been included in the list of general causes, though there is not much doubt that, in some cases at least, it acted locally rather than systemically, through the production of gummatous deposits at or near the site of fracture. In the opinion of those of wide experience, however, its effect is regarded as acting constitutionally rather than locally.

Other general causes have been given as malaria, starvation, severe hemorrhage, pregnancy and lactation, acute febrile diseases, diseases of the central nervous system (particularly tabes and general paresis), cachexias of various kinds, nephritis, and diseases of the ductless glands.

In pregnancy calcium salts are well known to be diverted from certain at least of their storage depots. This is perhaps best shown in the softening of teeth and the giving way of varicose veins which have been previously buttressed by calcareous deposits. As calcium is necessary to callus formation it is natural, if hypothetical, to suppose that in pregnancy the process of bony consolidation would be retarded. The writer has, however, not been able to find any well authenticated cases where pregnancy has delayed union, and is, therefore, forced to consider the influence of pregnancy on the repair of fractures as of academic rather than practical importance. By perversion of the calcium metabolism (disorders of the thyroid, thymus, pituitary etc.,) calcium may be diverted from the callus, which thus remains soft. Yet we have no evidence that gland feeding accelerates or retards the process of bony consolidation (Hawley). The bones of tabetics and gen-

cral paralytics seem to unite with very fair readiness. The influence of systemic conditions, as enumerated above, is probably much overrated, although isolated reports stressing one factor or another of supposed importance are still to be found. To sum up briefly, while constitutional disease naturally calls for treatment when complicating a fracture, its importance, compared with the actual local condition of the fractured bone-ends, is in most instances insignificant, syphilis being the exception.

The locally acting causes which delay and prevent union are much fewer in number than the constitutional causes, but are of the utmost importance.

(1) Non-apposition of the fractured bone-ends, whether due to loss of substance or to overriding. Loss of substance as a cause of delayed or non-union is found principally in military surgery, and is too often due to over-zealous débridement. With the terror of sepsis confronting him, the army surgeon has only too frequently removed fragments of bone that would have been invaluable as furnishing continuity of the broken shaft. Specimens of compound comminuted fracture prepared for the Canadian Government show most clearly how, in spite of virulent infection, small fragments of bone not only retain their viability but are capable of throwing out osteoblasts and so effecting union with neighboring pieces. When several inches separate the bone-ends non-union is the rule, though in many instances bone regeneration has spontaneously filled the gap in a surprising manner. The effect of extensive loss of substance on union may be minimized in cases where, as in the humerus, the sacrifice of several inches in length entails little disability. In the femur also one or two inches of shortening may with little difficulty be overcome, with the result that in the case of either of these bones, loss of substance, providing it be not too great, can be robbed of its dangerous tendency towards non-union by the simple expedient of lessening the extension, shortening the limb and allowing the fractured bone-ends to meet. In the case of loss of substance affecting one of paired bones, however, the difficulties are much greater, as the intact bone prevents any shortening on the part of its neighbor.

Overriding of the bone-ends is another form of non-apposition. While this is popularly supposed to be a fruitful source of non-union its usual effect is that of merely delaying consolidation. A study of x-ray plates of healed fractures will show that many of the firmest results are to be found in cases where overriding is present. If, indeed, non-union habitually followed overriding we should have infin-

itely more trouble with our fractures than is the case. Where non-union is found with overriding it is likely that there will be also present either imperfect immobilization or the interposition of soft parts. It may also be added that with our present methods of skeletal traction overriding of the bones, of the lower extremity at least, can, with few exceptions, be overcome, providing, of course, that union does not exist.

(2) Interposition of soft parts between the fragments, a mechanical bar to consolidation thus being formed. Such a condition is common in civil practice, but in war surgery is seldom seen. Fractures in military practice are, as a rule, caused by bullet or shrapnel, and the wounds have been promptly explored. Any fragments of fascia or muscle lying between the fragments would have been found and removed. Fractures in civil practice, on the other hand, are more often simple than compound, and even when compounded are comparatively infrequently the seat of a virulent infection so often seen in injuries received in battle. Interposition of soft parts is to be assumed when, in spite of good alignment and end-to-end apposition, union does not take place. Operation is thereby indicated.

(3) Faulty immobilization. Under this heading is to be included not only imperfect fixation but also the retention of apparatus for immobilization for too short a period. Too much freedom of movement permitted at the site of fracture has often the result of pulling upon or even breaking the soft early callus, with the effect of substituting fibrous for bony union, while in still earlier stages of repair a sudden and unguarded movement may transform end-to-end apposition into overriding with the interposition of soft parts. Too much handling of the fracture by an impatient surgeon, with resultant delay in union, comes under this head. It is interesting to note that such a condition is commoner in civil than in military practice. In civil life the surgeon has comparatively few fractures to deal with, and as a result may be at times led by misdirected zeal to take down the splints from a fracture and stir the bones about at precisely the time when the fragments need nothing so much as absolute immobilization. In times of war the surgeon is greatly overworked and has but little time to spend with his patients. Let him but once have his fracture cases splinted and dressed to his liking and they will be allowed to heal undisturbed.

Immobilization may be continued for too short a time, with the result that the early callus has not acquired sufficient strength to withstand the shocks incident to returning function. It is natural that

such a condition should be found in connection with fractures of the lower extremity. It is by no means uncommon for a thigh fracture which has been thought firmly consolidated to become re-fractured, with subsequent danger of delayed or non-union. Fractures of the lower part of the tibia have also been somewhat frequent offenders in this regard.

In connection with the question of faulty immobilization and its bearing on the union of fractures it is interesting to remember Lucas-Championnière's doctrine of the disregard of fixation. In fact some writers give too perfect immobilization as predisposing to delay in union. This is probably an error, and the delayed union must in such cases be sought for in a restricted circulation brought about by too tight bandaging or splinting.

(4) Sepsis, generally acting through extensive necrosis and bone abscess. Virulent sepsis is a destructive agent under whose influence large portions of bone necrose, with resulting gross loss of substance. Mild sepsis, on the other hand, seems to act as a stimulant to callus formation, as witness the extensive osteogenesis in mildly septic fractures. It may be recalled, also, that spurs of bone on amputation stumps are found only in infected cases. In septic fractures delay is the rule and non-union the exception. Delay in union is generally due to the presence of necrotic bone-ends or of sequestra. It is to be noted that the importance of mild sepsis, in regard to its influence on the union of fractures, has been greatly exaggerated in the past. It undoubtedly delays union, but rarely succeeds, when suitably treated, in preventing it.

(5) Bone tumors, especially sarcoma and metastatic carcinoma, cystic disease, acute rickets, scurvy, osteomalacia, and bone disease of all kinds existing at the site of fracture, *e.g.*, gummata, tuberculosis, etc.

(6) Defective blood-supply by too tight bandaging or splinting, thus producing an attenuated and bloodless limb, also by severe trauma to soft tissue adjacent to the fracture. Occasionally defective blood-supply to a fragment, as a rule the distal, by rupture of the nutrient artery to the bone. This is said to be especially frequent in the tibia and humerus. It is possible that defective local innervation may be a cause.

(7) In certain cases of delayed, but especially non-union, no cause can be assigned. A good example of this is seen in the refusal to unite of some cases of osteotomy for bow-legs. In the cases reported the bone has usually been found to be very dense, in consequence of

which the osteotomy was performed by means of a saw. The extreme hardness of the bone has been by some thought to militate against callus formation, by others the blame has been laid at the door of one or other of the ductless glands. One explanation, which has the merit of plausibility, is that the heat generated by the use of the saw rendered necrotic the bone-ends by searing them, thus preventing union. The question cannot be regarded as settled, though the relative scarcity of osteoblasts in dense bony tissue undoubtedly has a bearing on it.

(8) In certain cases the blame for non-union may be, it would seem with justice, laid at the door of metallic plates, nails, screws, wires, etc. Even in the absence of appreciable sepsis, one can in many cases make out an area of bone absorption in the immediate neighborhood of foreign bodies such as these, with a corresponding lack of callus formation. Where such a condition is to be found connected with delayed or non-union it is but natural to argue that the metal plates, screws, etc., are foreign bodies that by the irritation of their presence are responsible for the lack of callus formation. In many cases of this nature the removal of the offending plate or screw has been followed by satisfactory union. One explanation of the failure of union following metallic bone-plating is that the rigidly held fragments, in end-to-end apposition at the time of operation, become separated by the absorption of the bone-ends which form an early phase of bone repair. The gap thus formed naturally acts as a bar to union. It is interesting to note that Sir Arbuthnot Lane himself claims to have no such results following bone-plating. His contention is that such areas of osteoporosis in the neighborhood of metallic plates mean flaws in the operative technique of the surgeon, and are the result of sepsis of mild degree. There can be little doubt, whatever may be the individual feeling with regard to metallic fixation, that the use of plates and screws, etc., is being more and more confined to cases where (1) the bones are large and the blood-supply correspondingly ample, and (2) where, as in cases of malunion, unusual force is necessary to hold the bones in the desired position. It is also fairly well established that following the use of metallic plates, screws, etc., the surgeon incurs a far greater risk of sepsis than would follow the use of absorbable suture material.

DIAGNOSIS.

Delayed union is to be diagnosed when, following a fracture, consolidation is found to be weak after a period which usually suffices to effect union. Consolidation of a gunshot spiral fracture of the femur

has been observed to be sufficiently advanced at the thirtieth day to allow the patient to raise his heel from the bed. Following osteoclasis for bow-legs in a child of three, beginning union is easily distinguishable one week after operation. For strong union, however, in the femur two to three months are necessary, in the humerus about two months, in the lower leg and forearm about six to eight weeks. The diagnosis of delayed union rests largely on the discovery of undue mobility, usually accompanied by pain on movement, at the site of fracture. There will, in addition, be weakness of the limb. Non-union ordinarily is to be diagnosed only after six to twelve months of treatment directed towards promoting consolidation of the fracture, in the absence of which treatment the case is to be diagnosed as delayed union rather than absolute failure of union. The diagnosis of non-union rests on the persistence of signs and symptoms of the original fracture, *i. e.*, unnatural mobility, pain, weakness, etc. It is to be insisted upon that there often exists great difficulty in distinguishing between delayed and non-union. A very common error is to diagnose as non-union, and therefore treat by operation, a condition where in reality union is only delayed and where, with patience, consolidation will be effected by conservative measures alone.

TREATMENT.

An attempt has been made to emphasize the difference between delayed union and the graver condition of non-union, and it may be pointed out that the difference between them as regards treatment is equally well-defined. Speaking broadly, the treatment of delayed union is conservative while the only treatment of non-union is to operate, unless, of course, one is content simply to furnish some form of retentive apparatus and let the fracture go.

TREATMENT OF DELAYED UNION.

It is assumed that any constitutional or general disease is to be treated as vigorously as possible. The possibility of syphilis is to be borne in mind especially, and if there be the slightest suspicion of this disease, a Wassermann examination of the blood should be made (Estes).

There is in fracture work a great temptation to have a look at one's results too early. A fractured femur, for example, will be taken down at five or six weeks and examined. The surgeon, heedless of the fact that this is precisely the time when the strictest immobilization is nec-

essary, stirs the leg about and is horrified to find weak consolidation or none at all. What is in all probability a simple case of delayed union is thereupon diagnosed non-union, with consequent operation. This is bad surgery, as the case, if allowed to go on splinted and untouched for another few weeks, would very probably have resulted in firm consolidation. Provided that bony apposition and immobilization are good, taking down a fracture is unnecessary, and with sufficient time the great majority of cases will unite. Meddlesome surgery is, therefore, a factor to be considered and avoided. Do not diagnose delayed union, and still less non-union, until your time allowance has been ample.

Another point to be remembered is that recently healed fractures should not be put to work too soon. Many cases of Pott's fracture in particular give way under the strain of too early walking. The tibia, too, is, at best, somewhat indolent in its power of repair. Whether or not this be due to the fact that in its lower extent much of its shaft lies subcutaneously and hence has a scanty blood-supply, fractures of the lower leg frequently require the support of an ambulatory brace for a couple of months. This matter is even more to be emphasized in the treatment of hip fractures where, as a rule, three months' time should be allowed for consolidation. After this period weight-bearing may be cautiously begun. Refracture of a femur, even with the patient remaining in bed, is by no means an infrequent occurrence due to too early removal of splints. At the same time it is of the highest importance that the joints adjacent to the fracture should not be allowed to stiffen from prolonged immobilization (Willard). Passive motion of such joints should be practised at as early a date as is consistent with the safety of the fracture.

After these negative points some positive factors may be considered. The principles which will in 95 per cent. of cases give union are of the greatest simplicity. We are examining now, let us suppose, a simple fractured femur of ten weeks' standing. (1) Has it good alignment with good length, checked up by antero-posterior and lateral (or better still, stereoscopic) x-rays? In other words, has the fracture been well reduced? Try to get a certain amount, at least, of end-to-end apposition, the fractured bone-ends being engaged. This is not a *sine qua non* as regards union, as consolidation is often got with extensive overriding. In either case union should occur unless there is tissue between the bone-ends. It is interesting at this point to note the belief of some members of the Canadian Army Medical Corps that anatomically perfect reduction gives union which is not so strong as that seen

in the case of end-to-end apposition with some lateral or antero-posterior displacement. They point out that callus formation is much more exuberant in the latter.

(2) Next, is immobilization good? See that the fractured bone-ends are kept in apposition with the minimum amount of motion.

(3) As union cannot take place without a good blood-supply, are the splints or bandages too tight? Too many fractured limbs are found to be blue, cold, and wasted when the bandages are removed. Plaster of Paris is a frequent offender in this matter of circular compression, as also in the maintenance of good length.

These then are the first points to be noted in our hypothetical case of delayed union in a simple fracture—good alignment and length, good immobilization, and a good blood-supply. If any one of these three is lacking it should be corrected. If a fractured femur passes these tests at ten weeks let it alone and nature will in most cases do the rest. Where these rules have been observed and union is still lacking after three or three and a half months, the old percussion and damming treatment, instituted more than a generation ago by Thomas of Liverpool, holds good. Take the femur, break down the soft callus and turn the bone-ends toward the skin and beat them with a padded mallet. If overriding exists put on strong extension, preferably skeletal, and hold the gains with a Thomas knee-splint. Apply a rubber bandage tightly three or four inches above and below the site of fracture, thus bringing on venous congestion. Leave the bandage on at first twenty minutes per day, increasing gradually to several hours daily. This method was developed by Bier of Berlin and is erroneously termed Bier's hyperæmia, as it originated with H. O. Thomas. Usually in two to three weeks after this form of treatment callus is thrown out. It is to be noted that damming both above and below the fracture is preferable to the use of a rubber band applied above the fracture alone.

Among the most popular forms of local treatment for delayed union may be mentioned baking and massage. The baking is, as a rule, carried on by heat from electric bulbs in suitable holders or by electrically warmed pads bound over the site of fracture. After baking for half an hour there is an active congestion of arterial blood, and the pain and tenderness of the fracture have markedly decreased, thus permitting massage to exert its most stimulating effect. In the department of hydrotherapy the "*eau courant*" baths have proved of value. The limb is placed in these baths, filled with hot water in constant agitation and bubbling with compressed air. These baths have much the same effect in general as have baking and massage. They

not only promote a greater flow of blood to the part immersed, thus strongly stimulating callus formation, but they have a marked effect in decreasing the sensitiveness of the limb. In this way a valuable opportunity is given to manipulate and mobilize the joints adjacent to the fracture, which only too frequently are found to be stiffened by prolonged splinting.

Galvanism and faradism would seem not to have any marked effect on stimulating bony consolidation. Diathermy, by its production of heat in the interior of the limb, should be of value along these lines. Electricity is, however, of service in relieving pain, and so can be used in preparation for massage or manipulation. Ionization and the use of the high frequency current are said to be of special value in this respect. It remains to be proved, however, that the use of the electric current in any form exerts a more beneficial effect in the production of callus than the simpler methods of physiotherapy as exemplified in baking and massage.

One ancient form of treatment has been the injection of irritants such as iodine, alcohol, zinc chloride, etc., between the bone-ends, with the supposed object of promoting bony union by the setting up of aseptic irritation. Such treatment dates from pre-Listerian days, and would seem an excellent method of promoting fibrous tissue formation, but not of advancing the growth of callus. The injection of tissue fluids, suggested in the first place by Carrel, has more to recommend it. Bier has advocated the injection of blood between the bone-ends, this to come from the patient himself. Bergel injects fibrin from horse blood at the site of fracture. These methods appear promising and even somewhat logical, but are not likely to become popular. At best by their use one is working in the dark. No one doubts that a good blood supply is essential to the healing of a fracture, but blood without osteoblasts is of no avail, and neither blood nor other body fluids contain these precious cells. It is probable that the good effects following such injections have been due to the opening up of new avenues of escape for osteoblasts imprisoned in the bone-ends. One writer (Kauffer) carries the matter to a logical conclusion by recommending the injection of granulated bone in vaseline between the bone-ends. This method is not likely to become popular, and appears to disregard the fact that dead osteoblasts introduced in this way could be of no service.

The use of various ductless gland extracts (pituitary, thyroid etc.) is advocated, but we have no definite proof of their value in hastening callus formation.

Drilling down upon the bone-ends through a small skin puncture is an old form of local irritation which has been revived of late by Wyllys Andrews of Chicago. His claims that such treatment rapidly leads to new bone formation can be accepted, especially as his findings coincide with the experience of Surgeon-General A. G. Wildey, R. N. The latter does an open operation, first removing a thin section from each bone-end to ensure freedom from fibrous tissue. He then performs what he terms "long-axial drilling," by which is meant, no doubt, drilling out the closed-up medullary cavity, as well as making longitudinal drill-holes into the cortical bone. An excess of callus in cases described as non-union has followed this method, it is claimed. As Wildey refreshes the bone-ends, it would be a difficult matter to decide whether the union got in his cases is to be attributed to his "long-axial drilling" alone. However, this method of drilling into the sclerosed bone-ends, thereby opening up an exit for the osteoblasts imprisoned in the medullary cavity and under thickened periosteum, is a highly logical one and, in fact, seems rapidly growing in favor. Where soft parts or fibrous tissue intervene between the bone-ends it naturally cannot be of service, as also where there is great loss of bony substance. As an adjunct to bone grafting it has been found of service, as it contributes materially to the successful "taking" of the graft (Gallie).

In leg cases delayed union can be hastened by the use of an ambulatory splint. The body weight is transferred to the tuber ischii by a Thomas knee-brace, and the patient is got out of bed and encouraged to walk about. Whether locomotion has the effect of increasing the general supply of blood to the leg, or whether the bone-ends are rubbed together by walking, at all events getting the patient up and about has a splendid effect on hastening callus formation. Ambulatory treatment is to be emphatically endorsed.

The treatment of delayed union in compound septic cases will be considered later.

TREATMENT OF NON-UNION IN ASEPTIC CASES.

It has been insisted on that the treatment of delayed union is essentially conservative, while for non-union the treatment must of necessity be surgical. It has been pointed out that the two main causes of non-union are (1) the interposition of soft parts between fragments, the latter frequently overriding, and (2) the loss of large fragments of bone either from actual destruction or by too zealous débridement.

In the first instance, that of the interposition of soft parts between often overriding bone-ends, the object of the operation is to get raw, bleeding, and healthy bone-ends into apposition and to hold them there; nature will generally do the rest. In the case of gross loss of substance the bone graft is the method of choice to bridge the gap, except where we are content to sacrifice considerable length of limb by allowing the bone-ends to come together. This latter method of treatment obtains more especially in fractures of the upper extremity, as in the lower extremity length of limb is of great importance.

In operations for non-union in aseptic cases the key-note must be simplicity. The less manipulation of the bone fragments, the greater is the security against sepsis. The operation for non-union of the femur is at all times a serious one. The simplest form of operation would be, it would seem, to cut down upon the fracture, remove the intervening tissue, freshen the fractured surfaces until the bone bleeds freely, drill the sclerosed bone-ends to insure the escape of osteoblasts, obtain end-to-end or lateral apposition by locking or some simple method of joinery, secure by an absorbable suture such as kangaroo tendon, and immobilize with the greatest care by splint or plaster of Paris. In cases of considerable overriding there should be preliminary traction, preferably skeletal. By the use of the "ice tongs" overriding in femur fractures can be almost certainly overcome unless union exists. In this way the sacrifice of much length of bone is avoided. The Hawley table will be found of service at operation, as a means of exerting traction. The bone-ends in aseptic non-union will be found sclerosed for possibly several inches from the fracture. The ends will be rounded off, and will be covered with fibrous tissue. The medullary cavity will be found to be sealed up, thus effectively preventing the osteoblasts of this region from performing their function of callus formation. The sclerosed bone-ends have no further power of bone growth as far as the periosteal osteoblasts are concerned, as these latter lie dormant and hopelessly imprisoned in dense bone and fibrous tissue. Beyond the bone-ends one will come upon healthy bone, with healthy periosteum and active osteoblasts both endosteal and periosteal. The bone-ends, their activity now come to an end after a brief period of effort, act as a barrier. The problem is to set free the imprisoned osteoblasts and to press into service those at a distance. In some instances union is achieved by sawing off half an inch or more from each bone-end, or until the bone bleeds freely. These smooth, slippery ends are now crenated with the bone-nibblers and the ends locked in apposition. Chances of callus formation are distinctly better if in ad-

dition the bone-ends are drilled into longitudinally at many points (Wildey) and the medullary cavity reamed out, as thus the imprisoned osteoblasts are given a chance to escape. Where osteosclerosis is extreme in its density and extends for two or three inches along each fragment, there are too few osteoblasts in the bone-ends, and what few there are possess too little vitality to effect union, as a rule. One must therefore call up the reserves, namely, the osteoblasts in the healthy bone beyond the sclerosed area. As has been said, the sclerosed bone-ends act as a barrier, and this barrier must be removed. This can be done in two ways: (1) by sawing off the sclerosed and inert bone-ends, thus sacrificing great length of limb, and (2) by the use of the inlay bone graft (Albee) of great length, long enough to bridge across the barrier from well within the area of healthy and active bone. The groove in which the graft is placed will open up the medullary cavity, thus bringing into action the osteoblasts of this area. The graft will be from the tibia, in most cases, cut from the subcutaneous surface and carrying with it both periosteal and endosteal osteoblasts. Two inches of the graft at each end, if possible, will lie embedded in the healthy bone beyond the sclerosed bone-ends, and in this way the graft will in all probability take.

The combination of overriding and osteosclerosis, taken together, presents rather a difficult problem, the solution of which depends on whether we are willing to sacrifice much or little length of limb. Mr. Hey Groves states that a patient by depressing his pelvis on the short side can get along very well with one and one-half inches of shortening of his leg, and that by the use of a high heel in addition, he can make up for another one and one-half inches of shortening. Hence one may get along very well, according to Mr. Groves, with a femur even three inches short. Groves, therefore, advocates removal of the sclerosed bone-ends generously until the bone is seen to bleed freely, getting end-to-end or lateral apposition, with fixation by plate, bolt or wire. In this use of metallic fixation he follows Sir Arbuthnot Lane. Sir Robert Jones, on the other hand, avoids, when possible, the use of plates or metallic sutures. Albee's method of inlay bone graft, extending through the sclerosed areas from healthy bone above to healthy bone below, seems the most logical method of treatment where one wishes to avoid shortening, and where a bone graft would seem strong enough to hold the bones in place. His theory is that the graft is in itself a stimulant to bone production. This may be so, for although the graft promptly dies when placed in its bed some of the osteoblasts on its periosteal and endosteal surfaces receive sufficient nourishment

from the surrounding tissue fluids to retain their vitality and live, thus furnishing additional power to bone production. At the same time no reliance is to be placed on the periosteum in regard to its supposed and time-honored function of producing bone (Gallie), and for this reason the presence or absence of periosteum on the graft is of little practical importance. Its chief claim to distinction lies in the fact that it controls the nutrition of the underlying bone through the communication of its numerous vessels with the vascular system of the bone to which it adheres. It is therefore obvious that stripping up of the periosteum during the course of an operation is to be done with the greatest care and to the minimum amount, to avoid underlying necrosis should infection ensue.

The placing of the inlay bone graft, then, frees many osteoblasts that would otherwise have lain dormant and useless. At the same time it would seem beneficial to bone production to treat the sclerosed bone-ends by drilling into them in all directions, thus allowing the diffusion of such osteoblasts as still survive in their depths. It must be remembered that in the larger bones (femur, humerus, tibia) almost every form of bone graft has a fair chance of success, as the blood supply is generally ample and there is sufficient bony tissue to provide an abundance of osteoblasts. Sir Robert Jones in this connection insists on the graft resting in contact with the medullary cavity, as well as, when possible, being enveloped, together with its recipient bone, in a petticoat of fascia, transplanted if necessary. Where much force is needed to keep the bone-ends in apposition or correct alignment it may be found necessary to make use of metallic plates, wire, etc. Gallie in such cases has used plates made of boiled ox-bone, held in position by bone screws or bolts. It is to be noted, however, that neither boiled bone nor living heterogenous grafts should be used to bridge any but short gaps, as the osteoblastic proliferation which takes place at either end of such a graft will almost certainly fail to reach its middle (Gallie).

In cases of considerable loss of bony substance one usually waits for several months in the hope that new bone may be produced. Failing this, one may sacrifice length of limb by allowing the bone-ends to come together in the expectation of union. This is not generally done in cases of loss of substance in the bones of the lower extremity amounting to more than one and one-half to two inches. In the bones of the arm, loss of length is of little consequence. As in non-union with the bone-ends in apposition, so in non-union with a gap to be bridged, the method of choice in the case of the larger bones is the inlay bone graft.

The graft must be autogenous and is best taken from the subcutaneous inner surface of the tibia (not the crest). Two factors are of the utmost importance here. (1) The graft must be sufficiently long to extend at least two inches into the healthy bone beyond the sclerosed bone-ends. (2) Immobilization must be extremely carefully maintained until the graft has taken. In cases of bridging a gap it is interesting to note the procedure used and advocated by Sir Arbuthnot Lane. Refusing to accept shortening, he gets the arm or leg to normal length by extension and holds the fragments firmly by a long metallic plate which bridges the gap. The space between the fragments he fills with a piece of bone generally chipped off from one or other portion of the bone that is the subject of operation. Good results are claimed by him. His criticism of bone grafting is that by its use insufficient immobilization of the fragments is provided, with consequent failure to unite. He insists on absolute immobilization, and does not consider that even an inlay bone graft holds the bones sufficiently immovably. In the case of non-union with much sclerosis of the bone-ends it is difficult to see how a considerable gap could be successfully bridged by Sir Arbuthnot Lane's method, unless both the sclerosed ends were well opened up by the chiseling incident to the making of the graft. Nor is his graft in contact with healthy medullary cavity, which Sir Robert Jones insists should be done. Granting that success has followed this method in operations on the larger bones, it is still more difficult to understand how union could be obtained in bridging gaps in the smaller bones such as the radius and ulna.

Non-union of fractures of the femoral neck is the rule rather than the exception. Where about ninety-five per cent. of fractures in general unite, only about ten to sixteen per cent. of fractures of the neck of the femur acquire bony union (Hunkin). British authorities have made the figure somewhat higher, estimating that union is obtained in the neighborhood of twenty-three to twenty-eight per cent. of cases. One is confronted, in cases of non-union of fracture of the femoral neck, not only by loss of substance due generally to bone absorption, by poor blood-supply and consequently poor bone-forming power, but also considerable deformity. The great trochanter, as a rule, is elevated, sometimes to such an extent that the fractured bone-ends are not touching. Non-union is most frequently seen in cases of the so-called intracapsular or sub-capital fracture. Pegging the femoral neck, together with refreshing the bone-ends through an anterior incision, seems the favorite procedure, and one that has met with a considerable degree of success. Whitman's abduction method is not ad-

vocated by him in cases of absorption of the femoral neck. The use of a bone peg is to be recommended rather than a metallic spike, which latter soon loosens owing to osteoporosis of the bone in contact with it. The bone peg, on the other hand, will under favorable conditions become an integral part of the bone in which it lies. It is not to be recommended that the bone peg should be carefully shaped and rounded off, but rather that it should be driven into the femoral neck in the rough, penetrating well into the upper fragment and following the track of a long hole previously drilled to receive it. Nor should periosteum remain on the surface of the bone peg, as this would act as a barrier between the graft and the recipient bone. Too much shaping of the bone peg, with the object of making it smooth and well rounded, has the effect of destroying any osteoblasts that might otherwise remain on its surface, to promote bony union. It must be conceded, however, that a metallic spike has the great practical advantage of being stronger than a bone peg. After the use of the latter, therefore, the greatest care must be taken to insure the most perfect immobilization of the hip region. Pegging of the fracture alone, without refreshing the bone-ends, has been advocated, but in view of the fact that the bone-ends always show sclerosis and that fibrous tissue is often found intervening, this would not seem to be a correct surgical procedure. The pegging operation is to be preceded by traction and other manoeuvers, such as internal rotation and abduction, with the object of getting the fragments of the femoral neck into alignment so far as this is possible. It should be followed by the application of a long plaster spica extending not only over the operated hip but fixing the sound hip as well. It is in the application of the plaster spica that the greatest care must be taken not to break the bone peg. The fractured area is best reached, to be explored and freshened, by the anterior route. The peg is introduced through a separate and more laterally placed incision over the great trochanter. The long hole in the femoral neck extending into the upper fragment may be drilled, but the bone is so cancellous in this region that a bradawl will be found to work well.

Brackett's method of transplanting the head of the femur to the trochanter was published in *The Boston Medical and Surgical Journal* for September 13, 1917. The surgical reputation of its author is the best guarantee of its usefulness. The writer's experience with it has been slight.

It should be noted that fractures of the femoral neck involving the great trochanter, under which heading would be included the so-called extracapsular fracture, unite with much greater readiness than is the

case with fractures near the femoral neck. Not only are the bones involved of much larger extent, but the blood-supply is ample. Osteoblasts, therefore, not only exist in great number but receive sufficient nourishment to encourage callus formation. In the case of fractures occurring near the head, so-called subcapital or intracapsular, conditions are very different. The femoral neck in this region is comparatively small, while the fragment consisting of the head and the adjoining portion of the neck derives its nourishment exclusively from a very small artery in the ligamentum teres. As would naturally be expected in consequence of such a diminutive blood-supply, there is little or no power of callus formation in this fragment. Thus, without impaction, the chances of union occurring in a fracture of this type are rather poor.

In the case of the larger bones, the femur, humerus, and tibia, it has been stated that almost any form of bone graft has fair chances of taking, there being an abundant blood-supply and plenty of bone substance to furnish a supply of osteoblasts. In the case of the smaller bones, however, notably the radius and ulna, bone grafting has had many failures. Some grafts refused to take, while others took for a time only to give way after some months. Too early and excessive use of the arm was at first blamed for failures of the latter class, but in some cases, at least, this was found not to be the true solution. Here the graft was discovered to have taken well at the ends, but to have given way in the centre, owing to the failure of new bone formation to permeate the graft in its entirety. In the case of refusal of the grafts to take, the mistake seems to have been largely one of disregarding the blood-supply and of overestimating the power of callus formation in bones of small size. The application of an inlay graft of ordinary size to one of the forearm bones involves so much trauma to the recipient bone that but little is left either of blood supply or of healthy bone. By the time the bed for the graft has been made and the sutures tied, so much dissection has occurred that there remains but little bone-forming energy in the mutilated fragments, too often quite insufficient to vitalize the graft. The same objection often holds true as regards the application of metallic plates and screws.

There are five methods of applying the bone graft in this region, as elsewhere. In cases where the medullary cavity is to be easily reached and reamed out, bone fragments have been sprung into place, an end engaged in the medullary opening of each fragment. It is to be noted that softer bones, such as rib and iliac crest, take here better than the denser bone from the tibial crest. At the same time grafts

from the subcutaneous surface of this bone have been found to give satisfactory results. To give the best results here the medullary graft, like the inlay graft, should project beyond the sclerosed ends of the recipient fragments so that they penetrate to the healthy bone marrow. As the fragments are frequently tapering and with sealed medullary openings this is not often possible, nor can this form of graft be well used when the ununited bones lie closely in apposition. The method of choice in dealing with tapering bone-ends has been to split these with a saw for some distance, placing a graft from the tibial cortex in such a manner as to engage between the cleft ends. A third method is to use boiled bone plates fastened in place by means of bone screws or bolts (Gallie). In bridging a gap such procedure is not to be advocated, owing to the low power of bone formation possessed by such heterogenous and boiled bone grafts. They are made of boiled ox-bone ground to the shape required, and are said to be satisfactorily, though slowly, replaced by new bone in cases where the recipient healthy bones are not much more than an inch apart as, for instance, in spinal grafts. Autogenous bone grafts, it is conceded, possess the power of new bone formation to a comparatively high degree, whether taken, for instance, from the tibia to be used as an inlay, or from one of the fragments, preferably the upper on account of its better blood-supply, as a sliding graft. Sterilizing such a graft by boiling it retards the rate of speed by which it is changed into new and living bone, and hence lessens the size of the gap which it is capable of filling. Ox-bone grafts, or those taken from an individual not the one operated on (so-called heterogenous), will show a still slower rate of bone-forming power, except when the donor of the graft belongs to the same blood-group as the patient.

It has been shown that the use of the inlay bone graft has not proved so successful in the smaller bones as it has in the larger, for reasons already given. Chutro has advocated the method of using thin slices of cortical bone with the periosteum adherent, placing this in the space made by dissecting back the periosteum from the recipient bones. Periosteum is placed against periosteum, bone against bone. This method is said to produce the least amount of disturbance to the blood supply, and to be a promising one. It naturally cannot be used where force is needed to overcome bony deformity, as the wafer-like grafts have little strength, and are held in place by absorbable sutures. It has, in addition, the disadvantage of necessitating the stripping back of periosteum, thus jeopardizing, to some extent at least, an already feeble blood-supply. It is not though that it will replace the more

commonly used methods, particularly that of grafting between the cleft ends of the fragments.

SEPSIS IN DELAYED AND NON-UNION.

The war, by its multiplicity of gunshot wounds complicated by sepsis, has vastly increased our knowledge of the influence of infection on the process of union. Before the war sepsis was considered a most important cause not only of delayed but of non-union. Experience in army hospitals shows that such is not the case, as is proved by the comparative rarity of admissions for non-union. Septic fractures, after the first flare-up has died away, show a great amount of callus formation, and, contrary to our former belief, union is readily obtained when these often enormous masses of spongy bone are placed in contact. In fact, sepsis of a mild nature is a strong stimulant to osteogenesis and an assistant to union (Gallie). Where non-union persists in the presence of sepsis it will probably be found that either extensive destruction of bone has occurred, forming a gap too great to be bridged over, or else union is prevented by the presence of necrotic bone-ends or sequestrum formation. These act in preventing union both mechanically, by keeping apart the masses of newly formed callus, and also by the continued irritation of their presence retard the activity of the neighboring osteoblasts, until fibrous tissue formation mechanically prevents union from taking place.

It has been found that at a certain period after injury a time arrives particularly favorable to the union of septic fractures. At this moment, given as from about three to five months after the wound was received (Gallie), osteogenesis is at its height, vascularity is greatly increased, callus is abundant and the septic infection has run its course, and is now only mildly virulent, while, as yet, fibrous tissue growth is not sufficiently advanced to form a mechanical bar to union. It is at this time that best results are obtained in seeking for union. The wound should be excised, all septic tracts removed, walls of bone cavities chiseled away, sequestra got rid of, the ends of fragments refreshed and placed in apposition, and a very large drainage opening left, leading directly down to the fractured ends, so that in fact these can be seen. If any suture be found necessary it should be an absorbable one such as kangaroo tendon. Metallic sutures, plates, etc., act as foreign bodies and should not be used, even though by their means more perfect immobilization may be secured. Plaster fixation, with a window, may be applied after the first reaction has subsided, in about a week's time. In cases where there is so much loss of bone that the ends can-

not be allowed to come together on account of the excessive shortening thus produced, one must be contented with simply healing the wound and leaving the question of promoting union to a later date. By the recognition, then, that union is quite possible in the presence of mild sepsis, and is even at times hastened by it (Gallie), much time can be saved in treatment. It was not so many years ago that one was content merely with healing the wound, considering it hopeless to expect any effort at union on the part of septic bone-ends.

SEPSIS AND BONE GRAFTING.

While an inadequate blood-supply and lack of sufficient bony tissue in a healthy condition have been given as frequent causes of failure in bone grafting, it must be admitted that above all other causes sepsis is the great bane of this operation. Sepsis, then, at all costs is to be avoided. Any surgeon worthy of the name should be capable of operating without the introduction of sepsis from without, but in the case of an operation to graft bone for non-union following a septic fracture one of our greatest problems is to decide whether or not sepsis is lurking in secret directly in the path of the surgeon's knife. The onset of sepsis, whether from within or without, will inevitably destroy any chance of bridging a gap with a bone graft, which at once is destroyed by the infection, all chances of its taking being nullified, and which now becomes a foreign body fit only to be removed. It must be admitted, however, that at times union of the bone-ends, with taking of the graft, is seen even in the presence of sepsis, provided that there is end-to-end apposition of the fragments. It is without doubt a difficult problem to decide how long after a wound is healed it is safe to attempt a bone graft operation. The utmost care must be taken not to operate in the presence of infection, and there is no sure means of determining whether or not latent infection exists. British surgeons have advocated waiting a whole year after the closure of all wounds, and in most cases such a course is to be recommended in the case of severely comminuted and infected fractures. Other surgeons not so conservative and, possibly, with less experience, have reduced this time of waiting to six months. It is perhaps best that each case should be settled on its merits. X-rays give valuable information as to the presence or absence of sepsis in the bone-ends. If these show clearly, with no rarefaction nor sequestration seen and the bone-ends closed by a thin plate of compact bone, sepsis probably does not exist and it is justifiable to operate. If, on the other hand, there are spots of in-

creased density surrounded by osteoporosis, these are probably sequestra which by their presence denote infection. If the fragment-ends are surrounded by masses of callus and the shadow gradually fades away indicative of rarefaction, sepsis is probably still present and operation should be deferred (Gallie). Before even considering operation, four months after the healing of the wound should elapse in the case of small bones, and six months when dealing with large ones. Delay is also imperative on account of the greatly increased vascularity of the septic area, which takes place to such an extent that proper hemostasis is impossible. A large hematoma as a result follows too early operative interference, and lurking bacteria are encouraged to grow. Drains, it is now generally recognized, are dangerous. Before operation the limb is subjected to a final test by being massaged vigorously, to the point of pain. If no inflammatory reaction is produced one can be fairly certain that sepsis has come to an end. An operation in two stages has been advocated by some surgeons, and on good grounds when one considers how difficult, even at times impossible, it is to determine the question of the presence or absence of infection. At the first stage the wound is opened up widely and all the dissection necessary to place the graft carried out. The wound is then closed and a period of a week to ten days allowed to elapse. If sepsis has been encountered during this stage of the operation there will be a flare-up, which can, however, be generally made to subside with much greater readiness than if the operation had been carried on to its completion. Drainage will be much freer in the absence of the graft, which also would have needed removal if it had been placed in position. If no reaction follows, the graft is made and placed, no further dissection being necessary in the principal area of operation and hence no suppuration need be apprehended. Operative interference in two stages seems to be based on sound reasoning and is to be recommended in the cases where the question of septic infection cannot be satisfactorily solved. It is interesting to note, as emphasizing the importance of the subject, that Sir Arbuthnot Lane suggests the use of radium, vaccines or x-rays to sterilize embedded foci of infection (*Lancet*, January 5, 1918).

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RECONSTRUCTION OF THE INTERNAL LATERAL LIGAMENT OF THE KNEE-JOINT.

BY JOHN C. WILSON, M.D., LOS ANGELES.

Anatomy. The internal lateral ligament of the knee-joint is a flat, fibrous band which extends from the adductor tubercle to the upper medial aspect of the tibial shaft. Its length varies between 8 cm. and 10 cm. and its width, 8 cm. and 1 cm. The ligament is divided into superficial and deep portions and anterior and posterior fasciculi. The anterior fasciculus passes downward and is inserted directly into the tibia, and while crossing the internal meniscus gives off a few fibrous bands to the cartilage. The posterior fasciculus arises from the common origin near the adductor tubercle or from the anterior fasciculus below the tubercle, passes downward and backward, and is inserted into the medial meniscus. The semilunar cartilage, therefore, is attached more securely to the posterior segment of the ligament, thereby accounting for the injuries of the cartilage in flexion and external rotation of the knee when this portion of the ligament becomes tense. The posterior fasciculus may occasionally arise separately just behind the adductor tubercle and proceed downward and backward into the meniscus.

The lateral ligament may be easily differentiated from the capsule of the knee-joint. It is longer below the joint than above, the ratio being about 3 to 7. The anterior segment is taut when the knee is extended and relaxed when the knee is flexed.

The function of the internal lateral ligament is chiefly to stabilize the knee by preventing abduction of the leg in complete extension.

Pathology. The mechanism of rupture is usually forcible abduction of the leg without rotation when the knee is extended. In Case 1, the laceration was transverse, just above the superior border of the internal cartilage, the lacerated ends being separated about .5 cm. A thin white band of fibrous tissue which united the lacerated ends of the ligament could be demonstrated. Apparently this had very little tensile strength.

Signs and Symptoms. Patients with rupture of the internal lateral ligament of the knee-joint have one chief complaint, namely, an unstable knee when the leg is fully extended.

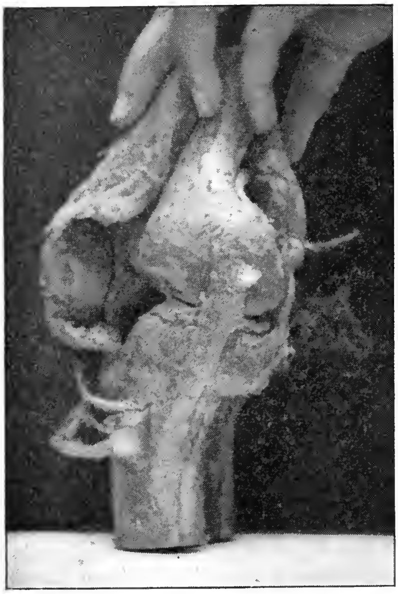

FIG. 1.—Photograph of anatomical specimen in which the internal lateral ligament may be clearly seen. The short posterior fasciculus terminates in the medial meniscus.

If seen after walking has been attempted or after a slight twist, there may be an effusion into the joint. Complete or partial dislocation of the patella is likely to occur, due to the change in the line of pull of the quadriceps femoris muscle or to relaxation of the tendon because of the unusual amount of knock-knee that may be found, as in Case No. 2.

Separation of the internal articular surfaces of the femur and tibia by abducting the leg in extension will be found if the internal lateral ligament is ruptured. Pain and tenderness at the site of rupture is not present in cases that are seen several months after injury.

Treatment. Edwards recommends the substitution of the tendons of the gracilis and the semitendinosus muscles. He divides these at the level of the medial condyle, the proximal ends of the distal segments being embedded in a groove prepared in the medial condyle of the femur. The divided distal ends of the semitendinosus and gracilis muscles are sutured together and the two secured by ligatures to the tendon of the sartorius muscle.

McMurray reports ten cases in which the sartorius tendon was advanced and embedded into the medial femoral condyle, thereby chang-

FIG. 2.—Photograph of an anatomical specimen in which the posterior fasciculus arises just below the adductor tubercle.

FIG. 3.—Photograph of an anatomical specimen in which the anterior and posterior fasciculi arise separately.

ing the insertion of the sartorius from the tibia to the femur, with good results.

After consultation with Dr. Michael Hoke it was decided that the problem of repair of the ligament could be solved by means of a pedunculated flap of fascia lata which could be implanted near the origin and insertion of the ligament. In this way, the normal mechanical pull would be reëstablished and the muscle balance around the knee undisturbed.

The medial aspect of the knee-joint is exposed by a linear incision slightly curved forward, through the skin down to the internal lateral ligament. This incision is continued upward to a point about 15 cm. above the adductor tubercle of the femur. After exposing the origin and insertion of the tendon, cortical flaps 2 cm. in diameter are turned back. A strip of fascia lata 15 cm. long and 3 cm. wide, is dissected free from the inner aspect of the thigh and reflected downward, being doubled on itself lengthwise, so that the band shall comprise three layers of fascia. In order to do this, it is necessary to divide the base of the flap one-third of its distance both anteriorly and posteriorly.

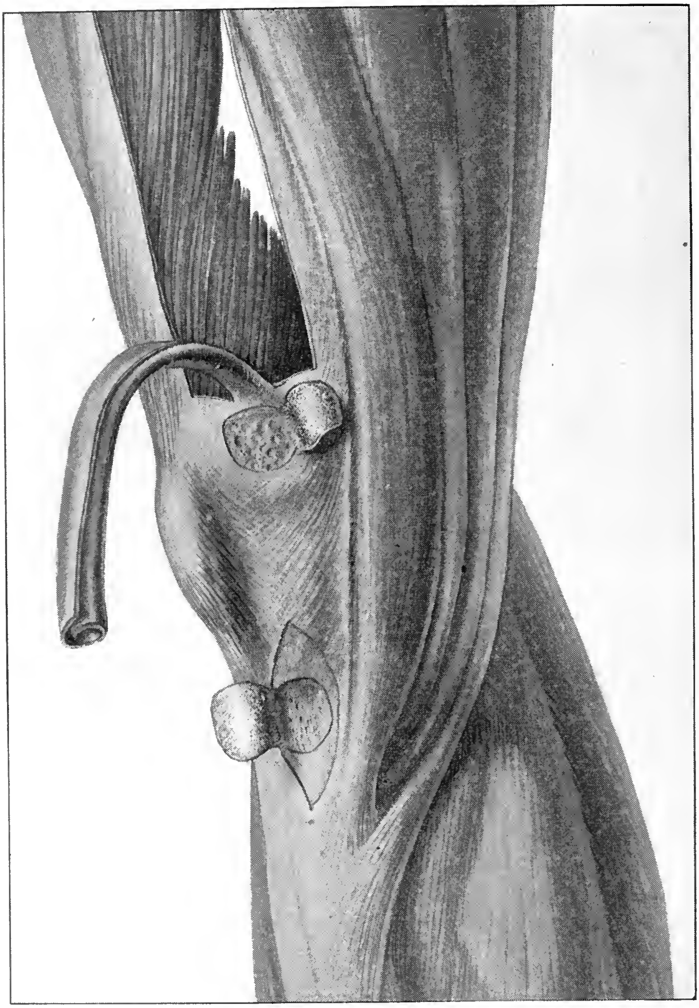

Fig. 4.

After the fascia is folded it is passed under the cortical flaps, which are then sutured in position, and the fascial band is further secured by a few sutures to the divided portions of the internal lateral ligament when possible. The tibial end of the transplant extends below the osteoplastic flap and is sutured to the periosteum and fascia. The leg is immobilized in plaster from the groin to the toes for eight weeks, when a long caliper splint is substituted and worn for a period of four

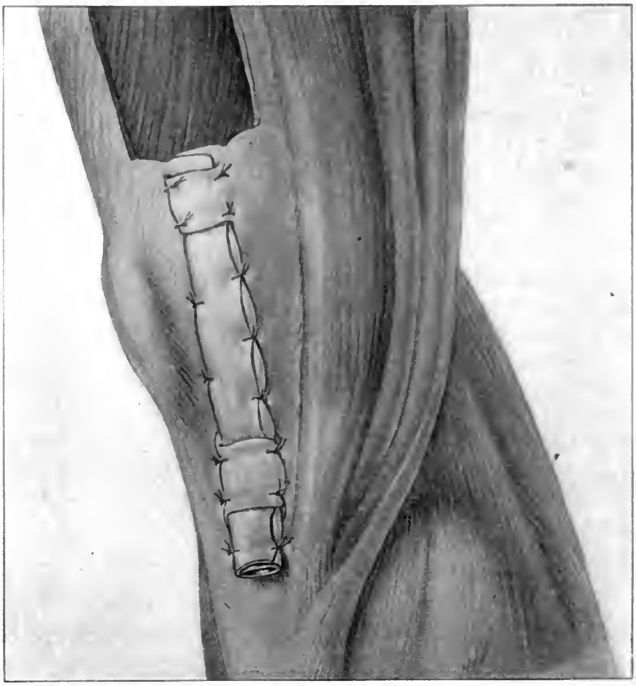

Fig. 5.

months. Flexion and extension of the knee should begin immediately after the removal of the plaster.

Case No. 1. A soldier, twenty-three years of age, was injured by a falling embankment of earth striking the outer side of the extended leg. Immediate disability followed, with swelling and tenderness over the internal lateral ligament. Fixation in plaster was carried out for two months, at the end of which time pain had disappeared, but sufficient abnormal lateral mobility in extension persisted to cause the leg to be insecure. The patient came under our observation six months after the accident, complaining of an unstable knee, the lateral instability being so great that he was obliged to walk with crutches. Examination revealed nothing except increased abduction of the leg in extension. In the absence of signs or symptoms of internal derangement. the disability was considered to be entirely due to laceration of the internal lateral ligament. The ligament was exposed and found to be torn transversely just above the superior margin of the internal meniscus. It was repaired by a pedunculated fascial transplant, the leg immobilized in plaster for two months, followed by protection in a long caliper splint for four months. It is now two years since this

ligament was reconstructed, and the patient reports that he has a knee that allows full flexion and extension in which there is no abnormal lateral mobility.

Case No. 2. This patient is a girl, aged fifteen years. At seven years of age she had a crushing of the knee, resulting in a compound fracture of the internal femoral condyle. Since this accident, marked genu valgum with instability in flexion or extension has developed. With the leg extended there is forty-five degrees of genu valgum, and the leg may be abducted to ninety degrees. The femur was osteotomized to correct the bony alignment. After two months of fixation, the union at the site of the osteotomy had become firm, but the lateral mobility at the knee persisted, due, apparently, to rupture of the internal lateral ligament. Consequently, the internal aspect of the knee-joint was exposed and no trace of a lateral ligament could be found. The capsule was rather thin and somewhat relaxed. A flap of fascia lata was turned down and sutured under osteoplastic flaps. After two months of fixation a long caliper splint was substituted and the patient began to walk. At the present time, fourteen months after the operation, the patient has a useful knee in which the lateral mobility has been entirely eliminated.

CONCLUSIONS.

1. Persistent abnormal abduction of the leg in extension without abnormal antero-posterior or lateral mobility in flexion is probably due to laceration of the internal lateral ligament.
2. Persistent instability due to laceration of the internal lateral ligament will require correction by surgical procedure.
3. A fascial transplant embedded in the femur and tibia near the origin and insertion of the internal lateral ligament has proven a satisfactory method of repair in two cases.

I am deeply indebted to Dr. M. S. Varian, who has made possible the study of the anatomical specimens used in the preparation of this article.

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THE SHRINERS' HOSPITALS FOR CRIPPLED CHILDREN.

"Behold how great a matter a little fire kindleth."

But the fire must find material to inflame, compelling it to ignite by its own energy.

Such a "great matter" is the purpose of the Mystic Shrine to provide hospital accommodations and care for the needy crippled children in the United States and Canada.

The original fire was one of the long-standing members of the American Orthopedic Association,—Dr. Michael Hoke of Atlanta. The immediately inflammable material has been the broad sympathy and devotion of two members of the Shrine, Mr. Freeland Kendrick of Philadelphia, and Mr. Forrest Adair of Atlanta. Kendrick and Adair conceived the idea of turning the thoughts of their fellow members toward service. Adair's idea of this form of service had been given by his experience as organizer and generous supporter of the Scottish Rite Hospital for Crippled Children in Atlanta. The chief surgeon and guiding spirit of this institution is Dr. Michael Hoke. His long orthopædic training and great mechanical and surgical skill and, more than all, his broad humanitarianism had been furnishing for Mr. Adair a wonderful example of the translation of these qualities into a form of service of the most appealing nature.

The vision was almost blinding in its light, and Adair and Kendrick and others succeeded in turning it into the hearts of their fellow members. An annual assessment was voted by the Imperial Council for this purpose. The expenditure of this annual income of over a million dollars has been entrusted to a body of men known as the Trustees of the Shriners Hospitals for Crippled Children. The committee is made up of influential members of the Shrine, a third of its personnel changing every year. The present Trustees are: Sam P. Cochran, Chairman, Dallas, Texas; W. Freeland Kendrick, Vice-Chairman, Philadelphia, Pa.; Forrest Adair, Secretary, Atlanta, Ga.; Bishop Frederick W. Keator, Tacoma, Wash.; Dr. Oscar M. Lanstrum, Helena, Mont.; John D. McGilvray, San Francisco, Cal.; Philip D. Gordon, Montreal, Que. They have asked five orthopædic surgeons to act as an Advisory Committee to the Trustees, to help them carry out the purpose of the foundation. Doctors Michael Hoke, of Atlanta; A. MacKenzie Forbes, of Montreal; Nathaniel Allison, of St. Louis; John C. Wilson, of Los Angeles; and Robert B. Osgood, of Boston, were chosen by the Trustees as an Advisory Committee.

Ten hospitals of simple construction, but thoroughly well equipped, have been authorized, and more are apt to be built as soon as the accumulation of funds justifies their establishment and maintenance. They are to be scattered over the continent and located in centers of population where the demand for such service to the crippled child is most felt. The first hospitals are to be built in Eastern and Middle Canada, California, Washington, Oregon, Louisiana, Missouri, Minnesota and New England. The patients are to include those children up to fourteen years of age who need skilled and free treatment for their deformities. They are to be teaching hospitals, in so far as possible, and the surgeon in charge, nominated by the Advisory Committee, is expected to give half of his time to the hospital work and is to be paid for his services.

Suddenly, without any "drive" and with much effort on the part of a few, but with comparatively little sacrifice on the part of many, the crippled child is to be cared for as never before. It is inconceivable that such a body of important business and professional men will turn back after having put their hands to the plow in all earnestness and from the highest motives. They have sought specialized professional help, that their work may be done wisely and their purposes fulfilled. The advice will be freely given and only too gladly.

The whole movement seems to us tremendously significant. Charity has gone hand in hand with civilization. We fought a war for the principle that it was the obligation of the strong to help the weak, but the burden has been borne in the past by too few of the strong. No one can read "Philanthropic Doubts" in the September *Atlantic Monthly* without being made acutely aware of this fact, alike unfortunate for the strong and the weak. Here is a great burden distributed among a large body of strong men. Instead of being a fatiguing load, it becomes an exhilarating service. Perhaps it is a still, small voice calling from the battlefields, of sacrifice for the sake of a principle, and heard through the length and breadth of the land. It is possible that other organizations will be stirred by this example to dedicate themselves to similar great purposes. The adult cripple and human derelict suffering from the effects of a quiescent, burnt-out arthritis, from an infantile paralysis, from a tuberculosis, and from the accidents of industry, cry for help nearly as loudly as the crippled child. Reconstructive war service has made the profession and the laity realize how very much can be accomplished by proper methods in the way of rehabilitation and wage-earning capacity.

"Behold how great a matter a little fire kindleth."

DISCUSSION ON THE OPERATIVE TREATMENT OF OSTEO-ARTHRITIS OF THE HIP-JOINT.*

MR. D. McCRAE AITKEN: When osteoarthritis of the hip joint was suggested as a subject for discussion, I do not think the word "operative" was included in the title. When it was suggested at a Committee meeting that I should have the honor of opening a discussion on this subject, I asked two or three of my colleagues what we were going to discuss. One said "You must exclude the general rheumatoid type, where many joints are involved, as we are not dealing with the cases which are frankly due to general infection in the body, but it is the monarticular type on which we ought to concentrate our attention." Another colleague said "What we mean are cases of traumatic origin"; my reply, that we should then have to include the pseudo-coxalgic and infantile types, was immediately objected to, which, I thought, was not logical, as I shall show later. Another said "We must include cases of stiff hip arising from acute inflammatory conditions." Now, if we reduce these various suggestions to their common measure, we realize that in the minds of that Committee was the wish to get a discussion on that type of stiff hip which is amenable, in certain cases, to operative treatment for producing a movable hip. I think what the Committee had in their minds was a discussion of our present attitude towards the operation of arthroplasty of the hip. But though all would like to hear the subject discussed, no one cared to say directly, "Let us discuss arthroplasty of the hip," lest he should be called on to open the debate.

In this debate we cannot entirely dissociate ourselves from a discussion of the conditions before and after operation. As you have said in your address, Sir, in the orthopædic practice of the past the use of the knife was held to be a last resort and an indication of the failure of mechanical effort. At present, especially in such operations as this, we must guard ourselves against rushing too quickly into operative methods which are now open to us, owing to advances in technique, in asepsis, as well as in operative detail, without first considering the question of the preliminary treatment which is necessary before resorting to operative measures, and—still more important—how we are going to get out of our difficulties afterwards by after-treatment and

*At the Annual Meeting of the British Orthopædic Association, London, November, 1920.

the restoration of the function of the part, which is the real *metier* of the orthopædic surgeon. Therefore, even if we take the title, as in the Agenda Paper, "Operative Treatment," we have to discuss what cases are suitable, what time or stage is suitable for the operation, and what preliminary treatment and what after-treatment must be considered. In this, as in all other disabilities, the surgeon has four points to put before himself. The first very important question is: What is it the patient complains of? He does not, of course, come with a scientific diagnosis, but his personal complaint is a matter of very great importance. Second, we have to consider its cause, its original cause, and such mechanical or infective contributory causes as have helped to produce the condition which we have ultimately to deal with.

Third, we have to consider the possibility of mechanical, operative or other means of eliminating the cause of complaint, whether the complaint be pain or stiffness. Then, fourthly,—and this I regard as the crux of the discussion,—what probability is there of recurrence of the disability after our treatment, owing to the continued action of the accessory causes, whether mechanical or infective, causing a return of pain, stiffness, and disability.

Applying these four points to osteoarthritis of the hip as it is before us, the complaint of the patient in these cases is, in rising order of importance to the patient, first, stiffness; second, stiffness in a bad position in which the adduction and flexion have produced a short leg; thirdly, pain. It is a remarkable thing that in a monarticular arthritis of the hip, stiffness is about the last thing a patient complains of. It comes on gradually, and if he does not have pain, he gets used to going about with a stiff hip. It is not, as a rule, until these patients have pain that they begin to ask for treatment. If a patient has a painless stiff hip, it is not usual for him to complain. This has to be remembered and considered.

Stiffness with a bad position is quite another matter, because the patient begins to limp as he walks and because the bad position and the wrong balance of the hip-joint is in itself a contributory cause to pain if the stiff hip is not absolutely rigid. Therefore we are very often asked by patients that some treatment may be carried out because there is adduction, flexion, and sometimes an important factor is the presence of rotation. Because if the thigh be rotated, the axes of the knees change, and the patient says the foot goes outwards, or inwards, when the knee is bent, and he thinks that interferes with his walking.

Pain is in an entirely different category: from the patient's point of view it is an urgent symptom, and when we have to deal with the ques-

tion of the treatment of pain it is always essential that something should be done for the relief of the patient. Patients who have arthritis of the hip and have suffered from pain have, in many instances, before coming to an orthopædic surgeon, resorted to practitioners of every conceivable variety, both qualified and unqualified; they have been subjected to all, or many, of the scientific methods of treatment—balneological, electro-therapeutical and other—and often associated with these treatments at watering-places they give a story of having been subjected to active manipulative treatment and movement with the object of "preventing the joint from becoming stiff." Generally speaking, we can lay down the rule that a joint which is painful on movement is demanding rest; it is an old law, which was laid down by Hilton, and has never ceased to be true of joints or anything else. Fortunately for me, my duty tonight is to open this subject for discussion and not to try to deal exhaustively with the matter.

We come, next, to the causes of these monarticular hip cases, though often the condition affects both hips though the patient may complain of only one. One member of the Committee suggested that these cases are traumatic. Often they are, though a history of trauma is, in many cases, hard to obtain. But I have noticed that monarticular cases are apt to occur in men who, in their youth, have been active footballers; the condition is common in hunting-men, and among others who have been much among horses, especially those who have had to do with breaking young horses to the saddle. Recently I had as a patient an elderly gentleman, who complained a little of pain but chiefly that his horses were getting broader and broader. On examination his left hip was found to be adducted with limited movement. A well-known bone-setter in Scotland had "manipulated a bone in the lower part of his back," and for a time thereafter he was better, he had some freer movement. I have here the skiagram of his case, which shows typical thickening around the acetabulum, such as we usually see in these osteoarthritic hips. If we are going to admit that trauma is one of the contributing causes, then we must remember that trauma produces at different ages different results. I have a skiagram here of trauma in which a child had the hip wrenched at nine months old, and also one in which the injury occurred at the age of eighteen months. In the x-ray of the former, taken at the age of eight years, it is to be noted that the epiphysis is broader than usual, while in the second, age twenty-three, the epiphysis is united to the shaft and shows clearly the typical mushroom head sometimes spoken of as pseudo-coxalgia. There is therefore to be considered, that trauma of the infant hip-joint produces an in-

jury of the head of the femur, ending in a mushroom-shaped femoral head, while in the adult, osteophytes form around the acetabulum. In contrast with that, here is an x-ray of a case in which the epiphysis of the head of the femur was removed last March on account of an acute abscess in the joint. In all these cases the patients arrived with adduction and flexion deformity and complaining of some pain. These cases are included among the hips for which some form of treatment will be necessary, though not necessarily as cases which will be amenable to treatment by arthroplasty. They all suffer from the same disabilities, namely: flexion, adduction, and pain. Methods of treating them, however, lead us to consider whether operation is always the immediate method which ought to be attempted.

Having begun with the story that there is generally some recurrent injury, such as produced by constant riding, we must never allow ourselves to forget that septic infection of intestinal origin, or sepsis from bad teeth, is an important factor in many of these cases, and changes due to infective causes may be superimposed on those due to the injury. In a recent article in *The Bacteriologist* it has been pointed out that in those cases of monarticular arthritis of the hip in which there are recurrent exacerbations, a certain organism has been isolated which seems to be pretty frequently associated with dirty mouths and painful joints in these cases. Therefore, one of the points which will have to arise for our discussion will be the elimination of possible sources of recurrent infective arthritis, even in a case which originally was frankly a case of traumatic hip. In this connection I may say I have a case which, so far as I know, is not traumatic. When I first saw her, her complaint was of stiffness of the right hip, and on skiagraphic examination, I concluded that some septic, infective process had been at work, but of this I was unable to obtain any direct evidence. There was, however, some coxa vara present. I treated her by abduction, as I had been taught by my Chief, and for a time she did very well. Then both hips began to be rather stiff, and the interesting fact came out that occasionally she was rather constipated. We had been trying to attend to that, and on a day when she had been suffering more than usual from pain and stiffness, she had lavage of the rectum done, and there was immediately a relief of the pain, and within a few hours she felt much better, and could move her hip more freely. I asked Dr. John Eyre, of Guy's, to go into the case, and he has been treating the patient with vaccines, and there has been an astonishing restoration of function. In that case, as you will see by the skiagram, there has been no osteophytic enlargement around the acetabulum, the head of the

femur is very firmly in the socket of the acetabulum, and there is no appearance of gap between the head and the acetabulum, and both are well defined. The condition of this patient varies greatly from day to day. Therefore the question is not a very easy one; we have many points to consider before we can say that these osteoarthritic hips will be amenable to any one method of mechanical or operative treatment.

Returning once more to the treatment of the case, I shall take, in the inverse order, the points raised. And first we will consider pain. It is an established fact that pain in these hips is immediately relieved when the hip becomes absolutely stiff, and we have always at command the simplest and safest method of relieving the complaint of pain, by fixing the hip absolutely. That may be done temporarily in many cases, by fixing the hip in plaster of Paris, as no doubt we all have done at times. In the early stages a few weeks, or a month or two, of fixation in a plaster spica in slight abduction is essential. In any position of adduction there is a strain in the hip-joint every time weight is put on, and this will maintain irritation and pain. But if the thigh can be fixed in abduction the weight falls more directly through the head in the acetabulum and down the neck of the femur. In this way, it is possible to put these hip-joints into a state of rest, because the more direct transmission of body weight in the abducted position eliminates much of the mechanical strain on the joint. This may ultimately lead either to a relief of pain with the giving of an increased range of movement, or, if the process is too advanced, to relief of pain, with a firmer ankylosis. With regard to the cases in which the patient complains of intolerable pain, the method of treatment, by operation or otherwise, is very gravely changed if both hips are stiff. I have already said that many patients with a single stiff hip, so long as there is no pain, will make very iittle complaint about it; they are usually people over middle age, and they can perform such activities as they wish to at their age, if they have one freely movable, flexible hip. When both hips are affected, the mechanical problem of getting a functional efficiency—I do not say competency—is very different, because, for the patient's comfort, he must get at least one freely movable hip. The first case I saw of operative double ankylosis of the hip was in one of your wards, Sir, in Liverpool, eighteen years ago. The case was frankly traumatic in origin. When working on a building, the man had slipped off a scaffolding and had landed on both feet. He got up, but felt stiff in both hips. He went on with his work, but in six months he had been getting stiffer and stiffer, and when he came to hospital, x-ray photographs showed firm bony ankylosis of both hips. This

had been of gradual onset. You did a subtrochanteric pseudo-arthrodesis, beginning with the left hip. It consisted of simple exposure of the femur immediately below the great trochanter, turning down a flap of the vastus externus from its upper attachment just below the trochanter, excising freely rather more than an inch of the shaft just below the trochanter and turning in the flap of the vastus over the top of the shaft. He was then given the ordinary routine treatment in Liverpool: passive movements on a very small scale, which were begun at the end of a fortnight. I was told subsequently that a year afterwards he was doing so well that he came back and demanded that the other hip should be operated upon. Some years ago, I had a patient who had the right hip ankylosed, and the left hip was so painful that when his bed was accidentally touched he screamed with pain. The x-ray picture showed so much osteophytic outgrowth all round, and the condition was so acute, that I did not think it was a case in which any operation on the joint would result in anything but absolute ankylosis. The operation I decided on, therefore, was exposing the upper edge of the joint, running a gouge in between the acetabulum and the head, rawing the bone, and producing complete ankylosis of the head and acetabulum, and at the same time I did the operation I have just described, dividing the shaft, removing about 1¼ inches of shaft, and turning in the vastus over the end of the shaft. The acute pain of which he had been complaining ceased after the operation, the leg was no longer a lever jarring that head in the acetabulum, and the head ankylosed firmly. It is to be noted that even if the joint itself is not touched, excision of portion of the shaft below the trochanter usually relieves the pain at once. This patient now goes into Shrewsbury every day on a motorcycle, a distance of ten miles. He had an accident when on his motorcycle, and got his leg rather twisted, and a bad dislocation of his pseudo-arthrosis, which was fixed up at once by Miss Hunt in plaster, and he is now getting about as before.

I pass now to the question of arthroplasty. I have already sent round the skiagram of a boy whose epiphysis had been removed. Experience shows that in inflammatory cases in which free removal of the head of the femur has been necessary, abduction of the thigh, adjustment of the remainder of the neck in the acetabulum, which is blocked with inflammatory fibrous tissue, results, in many cases, in a movable joint, which goes on to be a wonderfully effective joint. The limb should be put in this position at the time of operation. In cases of acute local inflammation which has completely passed off, but the head of the femur has been destroyed and removed, movement often returns

Therefore there is no reason why, in suitable cases in which there is no septic condition, we should not perform an operation, more skillful, perhaps, than that which has been done by an inflammatory process, clearing out the acetabulum and making a false joint. The technique of that I shall leave to others to discuss in detail, those who have done the operation more often than I have—I know there are many here who have. I think the general opinion now is, that the best access is obtained by reflecting the trochanter major and getting good access to the upper and posterior parts of the head and neck of the femur, and gouging out the acetabulum freely, displacing the head out, and afterwards trimming it. The interposition of foreign bodies, such as metallic foil, is, I think, a thing of the past, and I shall be interested in ascertaining whether the opinion of this meeting is that autogenous fascial or muscular covering for the head is the material to be used. The point which, I think, is absolutely essential before we attempt any such operation, is that there shall be absolute care taken that any form of autointoxication, from teeth or intestine, shall first be eliminated, otherwise these joints will certainly again become arthritic and stiff.

Another point on which I desire information is, What is the most appropriate after-treatment? In the upper limb arthroplasty is comparatively easy, because the patient can perform unloaded exercises. But if a man is getting about on his hip-joint, he has his body weight to carry, and that contributes to the changes which occur in these cases.

I hope I have done what was required of me,—introduced the subject for discussion; I know I have not dealt with the real subject itself, so there is plenty of room for further debate.

Dr. J. B. Mennell: I am not able to contribute anything on the operative side, but a question was raised about pain and the possibilities of relieving it. One point, I think, we have overlooked, which it was my privilege to learn last year in America. When there is flexion deformity due to monarticular arthritis of the hip-joint, the patient, in order to stand upright, produces a lordosis, and this causes what Dr. Goldthwait refers to as sacroiliac strain. The pain due to this condition can be relieved to a marked extent by the use of a sacral belt-support. Many patients who have a movable joint, with perhaps slight limitation of movement, can be relieved by taking off the strain from the sacroiliac joint by wearing a belt such as Dr. Goldthwait described. Pain in the hip-joint may remain, but this is often trivial when compared with that due to the sacroiliac strain which is the direct result of the flexion deformity of the hip.

Mr. Dunn: I agree with Mr. Aitken that fixation of a joint in plaster frequently results in ankylosis in these conditions. I think it is important, therefore, that in the case of the hip the position should not be one of full abduction. Fixation in plaster relieves the pain in certain of these joints. In others more relief is afforded by the wearing of a caliper. Pain is certainly the most difficult thing to deal with in this condition. If there is deformity, without pain, it is usually sufficient to correct this by trans-trochanteric osteotomy. If pain is persistent even after fixation, operation must be considered.

Any operation to secure sound arthrodesis or a movable joint in these cases must be looked upon as a serious one. Results of arthroplasty are uncertain, so that in most cases it will be better to try and procure a sound ankylosis. For this it may be necessary to disarticulate the hip and remove all cartilage from both surfaces.

The age, general condition of the patient, and the type of work he expects to do must all be taken into consideration before deciding on operation.

Mr. Bennett: I feel much interested in this discussion. I have attempted to cure some of the sufferers from this condition, but I have never done any formidable operations for it. I have done what Sir Robert Jones taught me to do; in these cases it is sufficient—and you must not try to do more than to relieve the adduction by dividing the adductor tendons, stretching them and getting the limb into the abducted position. Mr. Aitken has tried to explain why the pain is present, and I think his explanation is right, though I could never quite understand why that should be. There is great relief in the majority of cases when one divides the tendons and abducts the limb.

With regard to the question of a weak sacroiliac joint and its relation to the condition which is under discussion, I have been very much interested in this, and I saw Dr. Goldthwait's work in 1913; since that date I have adopted his method of giving support to the pelvic bones. His belt is more elaborate than the one I use, but it really does not matter much what belt one uses so long as it is adjusted well below the anterior-superior spine, between it and the great trochanter, and very firmly bound. There is great relief of pain in the hip-joint by this method. The belt also helps what Goldthwait regards as the contact between the transverse lumbar spine and the sacrum, and which he has so well described. I wish to pay my tribute to the wonderful work done by Dr. Goldthwait in regard to hip and lumbar spinal conditions.

Mr. Harry Platt: Mr. Aitken and Mr. Bennett have spoken of the importance of abducting the hip in the early stage of osteoarthritis,

That, I think, goes without saying. But the title of our discussion is the *operative* treatment of osteoarthritis, and these cases are generally in a condition of incomplete ankylosis after a year or two of severe sciatic pain, the hip being ankylosed in the position of flexion and adduction. I was looking through some of the records of operations that I have performed in these cases during the last seven years—about 25 of them. I find I have been doing three things: arthrodesis, simple excision of the head of the femur, and arthroplasty. And, from the point of view of the after-result, the operation of simple excision of the head of the femur has given the best result of all. That operation is an easy one; it relieves the adduction deformity and gives one room to abduct the hip. And although you may not get a hip-joint which later allows much movement, yet in my cases the patients have been able to walk with comfort, with very slight limp, and with much *apparent* mobility, mostly due to the lumbar spine. Arthrodesis, in my experience, has been very unsatisfactory. I began doing it after I came back from Boston, where Dr. Brackett, of that city, was working intensively on this subject; he had his wards filled with cases of monarticular arthritis of the hip-joint, and he was doing arthrodesis on great numbers. I did not see, while I was there, many of the end-results, but I believe that from Boston the end-results, published last year, have been exceedingly disappointing. Many of the cases failed to get a true bony ankylosis, and in, I think—(quoting from memory) —75 per cent. of the cases the adduction deformity has returned. Arthrodesis, apparently, should be limited to younger patients, in whom one is certain of getting bony ankylosis in a shorter time. In my own experience, it has been interesting to see that the arthrodesis, at the end of a very long period of fixation in abduction—which has not always been easy to obtain—has given a result which has been characterized by a bad limp and poor function. The arthroplasties I have done have been merely the addition of a fascial flap to what is practically a simple excision of the head of the femur, and the end-results are not quite as good as those from simple excision, leaving a very good gap between the stump of the neck and the deep acetabulum. The essential feature in the operation of excision is to put the stump of the neck into the acetabulum, and put the hip-joint up in full abduction, keeping it abducted for a considerable time, without any fear of it ankylosing or stiffening up. These cases do not ankylose completely, they produce a kind of fibrous pseudo-arthrosis which seems to offer a very good chance of future function for the patient.

MR. S. ALWYN SMITH: I was surprised to hear Mr. Platt say his results of arthrodesis in the usual type of case were unsatisfactory. I was pleased to hear Mr. Dunn say he made a bigger job of it. I turn up the trochanter and clear out everything, to make sure there is good apposition, and my results have been quite good.

One other point is this: where you have a case with bilateral ankylosis of the hip in septic arthritic cases in which there has been spondylitis, and probably ankylosis of knees, in addition—I suppose such a case comes under osteoarthritis—how do you know when the fire has, as it were, burned out? I am supposing a case in which there has been sepsis of teeth, tonsil, gut, or prostate. I had a case which was very instructive, and I will mention it.

A boy, the son of a well-known surgeon in Canada, aged 21 when I saw him, had all joints of both lower extremities ankylosed, except his two ankles, and, in addition, ankylosis of all lumbar spines. He had to take up law, or wanted to, and so we had to enable him to bend in the middle, so that he could read. I went through his condition as carefully as I could. He had chronic constipation. We had him x-rayed, but the skiagram was said to reveal nothing. I had his prostate massaged, and he had perfect teeth. At 15 years of age, he was said to have tuberculosis. He had had balneo-therapy. The case was obviously septic, so I thought it would be safe to operate. I therefore did the arthroplasty which was advocated by Sir Robert Jones, taking a flap from the great trochanter, and removing three-fourths of an inch of neck, turning up the flap of the trochanter and nailing it up in apposition to the proximal end of the divided neck, so that there was a false joint. I also left sufficient soft tissue and opposed a fascial flap in addition. The result there was very good. Instead of his being on crutches and his two feet progressing together, he now had a stride of 33 inches, and he could stand. There was no camouflaging of the lumbar spines, because he was ankylosed; he could put his foot up on a chair, but there was very little leverage for his psoas: there is probably only one-fourth inch of femur above the psoas insertion. That was done five years after any septic manifestations. I was asked to do Murphy's arthroplasty on the second hip, to get a better leverage. I told them I did not know what the result would be. I did a Murphy operation, and everything went well for ten days, and then the whole condition flared up, and he had pains in every joint. Three months afterwards, his other hip, which I had done first, was the seat of a very acute arthritis. At that time I was saved further responsibility because the date was August, 1914. He went to Chicago, and Murphy

wrote me when I was in France, saying he did not know why it should have flared up in that way, and that he was having a bad time with him. That is one of the tragedies of attempting to do arthroplasty in which the process involves the original joint elements. I think one must ponder over the matter very carefully, and be sure of one's ground before one does such an operation. And I would like to know if any members can tell me how to be sure that the fire is dead, and therefore there is likely to be no further lighting up. It will be a long time before I do another arthroplasty for a similar condition. I have done three Murphy operations altogether, and the others were fairly good. There were 60° of voluntary flexion in one, and nearly a right angle in the other. In similar cases, I shall do one of the modified excisions of the joint which you, Sir, devised. In that, one does not get so much rocking as in removal of the head alone. And where removal of the head has been done, these are the cases in which I have seen adduction and flexion deformity afterwards. My experience has been different from Mr. Platt's: those are the cases which come to you with adduction and 30° of flexion, possibly owing to faulty after-treatment, not the cases which have had arthrodesis suitably done.

But the point I got up to ask about is, when is it safe, when can one be sure that infection is not likely to light up again? Personally, I do not think one can ever be sure about it.

Mr. R. C. Elmslie: I think Mr. Platt was quite right to remind us that our subject is the operative treatment of these cases. We are very much indebted to Mr. Aitken for starting by trying to differentiate for us certain particular types of cases, because one cannot regard osteoarthritis of the hip as an entity, and say the operative treatment of osteoarthritis is arthrodesis, or arthroplasty, or excision. We must recognize that there are different clinical types, and that in every case we have to consider the particular clinical type which is confronting us, the probable pathology of the joint condition, and particularly the age and general constitutional state of the patient.

I suggest that we can divide most of the cases upon which operation might be practicable into these types:

(1) There is the youngish patient, with a single hip affected. Those cases, I agree with Mr. Aitken, are, in a large proportion, traumatic, and I think many of them are the end-results of that "mushroomed" condition of the head which arises in early childhood through some trouble in the epiphysis of the head of the femur. The first description of it was published by our new corresponding member, Dr. Calvé,

as a particular form of pseudo-coxalgia. A characteristic of the condition and its end-results is that the head and neck of the femur are sometimes enormously big. One may cut down on the end of the femur and have to deal with a femoral neck which is 2½ inches thick, and this is an additional problem in the operation. I think other monarticular cases in young or middle-aged people are largely traumatic. I saw, recently, a woman with monarticular osteoarthritis who had a curious deformity, which I have never seen before; the hip was abducted to an extent which produced two inches of apparent lengthening. In her case the trouble is ascribed to a fall on the ice, in which her hip was forcibly abducted; this origin may have something to do with the position.

(2) The second type is that which Mr. Alwyn Smith was speaking of, and which was originally described as "spondylose rhizomelique—" by Marie, in which the spine, hips, and sometimes the shoulders undergo progressive ankylosis. These constitute a group of bilateral cases in which one feels almost forced to do some operation.

(3) There is a third definite group, in which an older type of patient has osteoarthritis, perhaps in one hip, perhaps in both, in which there is some mobility left in the hip, adduction and flexion deformity, and considerable pain. Under what circumstances are we inclined to operate in these cases? I suppose the two conditions which induce operation are: persistent pain and progressive deformity, and this deformity leads us the more certainly to operate if both hips are affected. Mr. Aitken called attention to the fact that the patient with osteoarthritis in one hip nearly always comes on account of pain, or for shortening, or for eversion, not because of stiffening of the hip. These patients, who will, perhaps, acknowledge having had pain for twelve months, when asked how long it is since they could put on their own boots, will reply, two or three years; the stiffness had been present longer than the other symptoms for which they present themselves for treatment. This has always seemed to me to be the indication of the best method of treatment in the monarticular type. And I am sure the line of treatment which is best for the patient, giving the best functional result, is to try to fix the hip in a sound position. To place such operations as arthroplasty or excision of the head as fair rivals of procedures which tend to fix the hip, you would have to show a remarkably good functional result from your excision or arthroplasty. I have not seen any results from arthroplasty of the hip which I can put in the same class as a sound ankylosed hip. Therefore, in the young type of osteoarthritis of one hip, I have, throughout, gone on the idea that I shall try to get an ankylosed hip in a good position, and if I can-

not get that ankylosis in a reasonable time by fixation in plaster or a splint, I have done arthrodesis. And I agree with Mr. Platt that to get sound arthrodesis is not an easy job. Still, I am surprised to hear him say that the operation is an unsuccessful one. I think he means it is only unsuccessful because it is difficult to get arthrodesis; I do not think that, having got fixation, it would be unsuccessful. One has to rely upon that operation, whether you do it by Albee's method, or by the more radical method of turning out the head of the femur and removing the whole cartilage, and clearing out the acetabulum with the arthrodesis gouge. It is a severe operation, and it takes a considerable time, involving, also, considerable shock. It also necessarily involves a long period afterwards of fixation of the joint. So it is an operation which one would not lightly undertake on a patient who was not fairly young and otherwise in sound health. I think such an operation for osteoarthritis of the hip in an old person is one which involves too much risk.

Then there are cases of double arthritis of the hip, with progressive ankylosis. I recently saw a young man who is in the twenties, who has, at the present time, complete fixation of his spine, from the cervical region downwards, and of the hips in a flexed position, so that when he stands he is tilted forwards. One hip has no movement, and is comparatively painless; the other hip has a small range of movement, and causes him much pain. I feel that he is still in the progressive stage, and that he has, probably, a septic focus somewhere, though it is an exception to find a septic focus in these cases of Marie's, and one is thus often left to deal with the spine and the hips as a purely mechanical problem. Holding, as I do, so poor an opinion of arthroplasty of the hip in general, I should feel great reluctance in admitting that arthroplasty ought to be attempted on such a joint, unless it is an arthroplasty which requires so much removal of bone as to get rid of all the joint elements. I think this type is best treated by frank excision of the head of the femur, and in this I am glad to find myself in agreement with Mr. Platt, who probably has considerable experience of excision of the head of the femur, and its results. I think the fear of the loose, weak joint, following excision of the hip, which I used to hold very strongly, is somewhat exaggerated; it depends largely on the results of excisions of the hip done by surgeons who could not be called orthopædic surgeons, it was excision of the head of the femur without proper after-treatment. It has been my custom, for some years past, to deal with old-standing cases of ununited intracapsular fracture of the neck of the femur by excising the

head. Every time I have done it, I have felt justified by finding that the pain is due to movement at the false joint, and that the head of the femur is atrophic, that its cartilage has largely disappeared, and that to reconstruct the hip-joint itself, if one could peg the head on to the trochanter successfully, would be practically impossible. After excision of the head of the femur, the only after-treatment necessary is to put the hip up in an abducted position. I use a pair of Thomas' splints, slung in a widely abducted position. Following six weeks in this position, I put on a caliper splint, which is worn for from six to twelve months.

The real difficulty of arthroplasty of the hip, in which the head is covered with fascia and replaced in the acetabulum, which has been cleaned out, is the same as in arthroplasty of any joint in the lower limb which is subjected afterwards to directly transmitted pressure. It is very difficult to get a permanent, good, false joint where that false joint is being subjected to the through pressure of the whole of the person's body. It is a different problem to get arthroplasty of a joint in the lower limb from that concerning a joint in the upper limb, where no such considerable pressure passes through the joint. I want to see a good deal better results from arthroplasties by other people before I go back to trying to do it myself.

There is another operation, one which has not been alluded to in the discussion, namely, that in which the head of the femur is operated upon for the removal of osteophytes around its margin, which are limiting movement in particular directions. This operation has a very limited scope, but I have done it in one case, myself, with great success. It was that of a young man, aged about 28, probably a late case of pseudo-coxalgia, with osteophytes. The osteophytes on the upper border of the head and neck were preventing abduction. There was not much pain in the joint, and the other movements were of good range. I exposed the joint, and removed large pieces of bone from the margin of the head, and thus secured an increased range of movement, which enabled him to ride: previously, he could not keep on a horse. The success of the operation was proved by the fact that he took a commission in the A. S. C. Mounted Transport, and went right through the war; after the war, he could ride well.

Mr. A. H. Tubby: I feel considerable diffidence in speaking on the question of the operative treatment of arthritis deformans, because my experience of it has been limited. With regard to the origin of the disease I crave your indulgence whilst I say a word: the opener of the discussion has also alluded to the matter.

There is an abundance of literature which supports the contention that a large proportion of cases is due to defective teeth; yet, that is not the whole question. We need to differentiate carefully what particular lesion in the teeth it is, which is associated with the more virulent forms of arthritis deformans; and, if I enter into personal experiences, I hope you will forgive me: I do so because it may be useful.

I had slight warnings of arthritis deformans for some years. Last summer, after a prolonged stay abroad, under trying conditions, the signs were aggravated. The removal of six teeth from the upper jaw had no effects upon the symptoms. Skiagrams were then taken, and five teeth were extracted from the lower jaw. The symptoms abated. At the root of the second lower right molar, a granuloma was found to be attached to the nerve, and came away with it. Herein lay, I believe, the cause of the trouble. Much work has been done by dental surgeons on streptococcus viridens and granuloma. Their experience is, that granulomata are capable of demonstration by x-rays. They are seen as small, oval, dark masses below the root, or roots, of the teeth, and it is of no avail to remove the teeth unless the granulomata are extirpated as well. If the granulomata are left, there will be, for a long time, a sinus in the lower jaw, and the signs of arthritis will persist, and even become aggravated.

And now with regard to other questions. Once arthritis deformans of the hip is well developed, the essential indications are quite clear, namely, to take the weight off the painful joint and, at the same time, keep it in movement. An article by me, on the subject, appeared in *The Practitioner,* in November, 1920, therefore I need not go over the points again, except to say that rest in bed, with weight-extension on the legs, with massage and occasional passive movements, is prescribed for some weeks until pain and spasm have subsided. Then, the patient is allowed to walk, wearing an apparatus which is so contrived as to transmit the body-weight directly from the tuber ischii to the heel of the boot.

With regard to operations on the hip-joint, or femur, I am convinced that their comparative want of success is due to non-recognition of this point, *viz.,* after you have operated, you should, by means of some contrivance, so arrange that the weight of the body shall not press on the joint which has been dealt with by arthroplasty, or on a femur which has been divided. Movement at the hip should be provided for, and intra-articular pressure be avoided. This is effected by the walking apparatus just alluded to. My experience in operating for arthritis deformans has been more extensive in the knee than in the hip. The

results after operation on the knee have been satisfactory and pleasing to the patient and myself, whereas those on the hip leave much to be desired.

"Sciatica," wrongly so called, is often a sign of commencing trouble in the hip. The pain is sometimes due to pressure of osteophytes on the sciatic nerve, and occasionally you may remove the osteophytes and a small part of the subjacent bone, and afford relief. I embark, only after considerable hesitation, upon any extensive operation on the hip-joint for arthritis deformans. I need to be convinced that the conditions of pain and loss of movement are such as to interfere seriously with the patient's health, and prevent his obtaining a livelihood. Persons of advanced years are very seldom fit subjects for any severe operation upon the hip.

Dr. J. Adams (Boston, U. S. A.): It is interesting for me, Sir, coming from America, to have the privilege of being present at this meeting of the British Orthopædic Association. Originally, we thought the centre of orthopædics, in America, was Boston, but we have been deposed from that position, I think, by the New York gentlemen.

The question of osteoarthritis has been very interesting ever since the inception of orthopædic surgery as a specialty, and I judge you have had the same fight in this country, to establish orthopædic surgery on the good basis it ought to have, as we have had in America. I feel that the subject has been so well covered today, that there remains very little which can be added, except that I am very glad to hear what has been said about the operation of arthroplasty of the hip-joint. I think we all, in America—I, personally, certainly—have had experience of a succession of failures after that operation. Reference has been made to Dr. Brackett's series of cases at the Massachusetts Hospital and his thorough investigation of the subject of arthrodesis. In certain selected cases in which the patient's condition will admit of such a serious operation, arthrodesis has proved of distinct value, but only in a low percentage of cases. To sum up the treatment of this disease, it seems to me that if we could so teach our general practitioners to call in the orthopædic surgeon at the beginning, in cases of rheumatoid arthritis, we should not be confronted with many of the surgical problems that we are seeing today. I feel, and most of us in the United States feel, that the conservative treatment of this disease, which is fixation in plaster, in abduction, until the patient's symptoms demand some further treatment, is all we can expect and accept. In other words, we fix the patient in plaster, in abduction, and when his symptoms become so intolerable that he demands further

treatment, we give him the operation of choice, placing before him the statistics which our experience has allowed us to use, as to the operation of election. The results are not extremely satisfactory along any line of treatment except the conservative one. I feel that many of the failures which are seen following the radical operation are due entirely to the fact that we have not allowed the inflammation in the joint to sufficiently quiet down before that radical operation was undertaken. At present, I think most of the people in America are in great danger of losing most of their teeth; we are passing through a furore of dental abscess, to which are attributed all the ills which result in the conditions we are discussing. A few years ago I was at Los Angeles, reading a paper before the Society there, and I have never seen one idea taking hold of a community as did the supposed specific cause of this, there, at that time. Whether that wave has travelled across the country eastwards, and even arrived at this country, I do not know, nor do I know whether it really originated in this country. But I think that in our attempts to find the focus in these crippling cases we lose much valuable time which should be occupied in the treatment of the condition which is present. We send patients about to those practising different specialties in the States, at a time when the patient should be resting in bed with the limb fixed, and having the specialist come to him, if it is necessary for the patient to be seen, to investigate the cause and the pathology.

Mr. A. B. Mitchell (Belfast): May I add my congratulations to you, Sir, on the efforts which you have made to establish orthopædics in this country on a sound basis? One of the most valuable results of the war has been to compel you to throw aside your natural modesty and come forward and force your principles on the notice of the profession. The profession in this country has responded nobly. There is no work which has been so heartily and generously recognized by the general surgeons in this country, as your own. They truly value the principles which you have so ardently and so persistently advocated.

The discussion to which we have been listening this morning makes me feel, more and more, that no man can undertake to treat one of these cases of osteoarthritis without the greatest sense of responsibility. The very fact that no one operation appears to give the desired result, that no surgeon, before he operates, can undertake to give the patient a definite, a perfect, even a moderately satisfactory result, makes it our bounden duty to put the facts before the patient, to tell him exactly what we hope to attain, the possibilities of failure, and leave him to decide whether he will entrust his future welfare to our care.

As put before us today, the question of osteoarthritis ranges over the whole tenure of life. Mr. Aitken sent round a very interesting photograph of a condition believed to be due to traumatism, in a child 12 months old. I hope he will excuse my saying, I am in doubt about that being an ordinary case of osteoarthritis. I hardly think the possibility of tubercular epiphysitis, with destruction of the head of the bone, can be eliminated in that case.

We come now to the other end of life. A gentleman of 65 to 70 years comes along—one who is otherwise well—and says, "Can you do something for the pain in my leg, which is getting stiff? I cannot lace my boots." Later, comes the agonizing pain which keeps him awake at night. As Mr. Aitken has well said, he goes to the general practitioner, then to the electrician, then to the quack. The quack, devoid of a sense of responsibility, and with his usual assertion that he can certainly cure, impresses him most of all. After a time, the man comes back to us again. You find he has a hip-joint the seat of hypertrophic osteoarthritis, with a lip round the acetabulum. Everything has been tried to relieve the pain. What can you do for him? Are there any operative measures which you are justified in proposing to him, considering his years and the time he would be obliged to be in bed? Supposing his hip-joint is just commencing to be involved, and he is afraid of being bedridden? He is prepared to endure any operation, even to face death, provided he can get some relief. I am satisfied that arthrodesis in such a man would not cure, nor end his sufferings. The prolonged after-treatment in these cases is really one of the great difficulties. I am pleased to hear, from Mr. Platt and others, that excision of the head of the femur gives a more favorable result than I have usually seen. In the cases I have had, it may be that the after-treatment was not sufficiently prolonged. I think the ordinary result of excision is a pathological dislocation. I think it is very difficult to get fibrous, or any other form of ankylosis, which will prevent dislocation in an upward direction when the weight of the body is thrown on the leg. If you are going to do that in a child, it will be much better to take away the neck, and try to fix the head in the acetabulum. I would like to hear opinions on that point. I am speaking from an experience which is not sufficient to give weight on a question of this importance. The cases of excision of the head of the femur, which I have seen, have ultimately got into a condition which is not favorable.

When is it safe to open and deal with a joint which has been the seat of arthritis of a toxic nature? This immediately raises the question of autointoxication. No one, I think, can deny the effect of trauma

in producing autointoxication. The simplest example is ordinary acute septic periostitis, or septic osteomyelitis. A boy gets a kick on the shin; there is no outside wound, yet in a few days he comes with an acutely inflamed tibia, and perhaps the whole periosteum stripped from the bone. The devitalization of the tissues produced by injury has induced the invaders to attack the weak spot in his defense. It is impossible to say that in the arthrodesis a mild degree of infection was not induced, which, in the ordinary way, did not manifest itself early. I am not questioning the care which was taken, but we are dealing with an individual whose resistance, probably, to septic organisms of all kinds is rather below the normal, and a mild operation, such as subtrochanteric osteotomy, which is fairly rapid and involves a minimum of damage to muscular and other tissue round the joint, is less likely to be followed by infection. In our hospital, in which, under you, Sir, I had the honor of supervising the orthopædic work, when joint or bone cases were admitted for treatment, we made a rule not to allow anyone to operate, to do a bone graft, or operate on a joint, until all inflammation and sepsis had subsided.

I am sorry I cannot give you any experiences of arthrodesis of the hip-joint. I have studied the literature carefully, and I have not, until now, felt that the proved results, after a reasonably good time, have been sufficient to make me feel I ought to do this operation of arthrodesis in an old patient.

Dr. Calvé (Paris): I accept your kind invitation to make two observations. First, osteoarthritis in adults is very rare in France, and it is curious to us French orthopædists that you, in England, so often discuss this question. In children it is very different. In America, there seems to be a special form of arthritis. In the child, this osteoarthritis is cured without surgery, by rest, perhaps for six months. Sometimes there is not more than a little pain. I think the trouble is largely due to the thickness of the cartilage; I think the actual articular surface is not involved. In some cases a little nucleus forms, and it is interesting to follow and observe that in the succeeding radiogram, first, there is one nucleus between the neck and the acetabulum, and then two or three, afterwards uniting to form one large one.

Mr. E. W. Hey Groves: I had not intended to contribute to this discussion. I came with the object of gaining information, and I may say I have done so, and with great profit.

I was much interested to see this subject had been chosen for discussion, because I think it is one which is becoming more and more im-

portant. I do not know whether the war pensioner is particularly liable to septic influences, or whether it is the late result of gunshot wounds, but the proportion of cases of severe, crippling osteoarthritis we have seen lately has been rather a painful revelation. They are becoming one of the biggest problems we, in the area I am associated with, have to deal with. I have the feeling that the advantages of excision of the hip, a comparatively simple operation, were very much greater than those of the more elaborate operations which have been proposed in the last decade. But I have a rather guilty feeling that perhaps it was that we had not carried out the more elaborate operations in the way they should be done, and so I thought I would not say anything about it. Still, I am encouraged by the rather large consensus of opinion which has been expressed today, to add my contribution to the weight of that opinion. When we hear distinguished orthopædists from this and the other side of the water speak about the importance of simplifying these operations, I have no hesitation in adding my experience to theirs.

In the first place, it seems to me that the comparatively elaborate operation of arthroplasty has not made good. I have done it; it is the sort of operation which makes a strong appeal to me; it was carefully thought out, it looks good, and to me it was attractive, therefore I set out biased in its favor. I cannot say in how many cases I have done it, but it is a considerable number. I have been very disappointed with it, indeed. It is a long, tedious operation, one of those operations in which it is very difficult to effectively control the hæmorrhage by a tourniquet; there is much oozing. In elderly patients, especially, it is a serious operation, and one in which it is very difficult to entirely avoid sepsis; there is much exposure, and many of the cases have previously been subjects of subacute septic absorption. At any rate, they are difficult subjects in whom to get healing by first intention. And even in those cases in which there has been no drawback and no accident, the functional result has been extremely disappointing. On the other hand, simple excision of the head of the bone has given very much better results. And I think the reason for that is two-fold. First, the inherently simpler character of the operation makes very much more for success; and, secondly, the fact that after the head of the bone has been removed and nothing but the neck is left, the mechanical strain on that region of the femur is very much less; that is to say, the bone acts more like an axial strut in the thigh, and there is not that stress and strain which normally takes place at the neck and head of the bone, owing to its particular shape. The third point is, that, going on

the suggestion which I first got from Sir Harold Stiles, after the head of the bone has been removed, if the neck of the bone is smoothed and then rubbed with a hard variety of wax, that will obviate the necessity for interposition of fascia; and under those circumstances, I think, excision of the bone gives an extremely good result. My feeling now is, that in all cases without much pain, but with much deformity, subtrochanteric osteotomy is the operation of choice; and in the cases which have much pain and it is desirable to get some degree of movement, some simple form of excision of bone, followed by rubbing in of wax to the neck, gives the best result.

Mr. A. Blundell Bankhart: I agree very strongly with much of what Mr. Elmslie said; that there should be a distinction between the case in which one does excision, and where arthroplasty is done. If you take away enough, you get a movable joint; if you take too little, it becomes fixed. I have seen a good many elbows excised in children, and some got stiff joints, some had flail joints, some good joints. The same applies to stiff toe joints. If you take enough bone, there is movement; if you take too much, there is stiffness. How much, then, will you excise? Murphy's original operation was not simply smoothing the bone and making the new articular surfaces: he laid stress on excising the capsule of fibrous tissue and even baring the bone and embedding it in a clean muscle bed and fat. Most of us who have tried that, have had a big wound, which it has been difficult to keep clean, and many of the people have suffered from infection afterwards. I have had two which were badly infected and were suppurating, and they had better movement than did any of the cases I have done which healed aseptically. I feel it should be possible to do arthroplasty, and I think that if we were talking to students or post-graduates, and teaching them established principles, we should warn them against arthroplasty. But I think the fact that other people have failed is rather an incentive to us to improve on the technique and try to succeed. I think past records are not reliable as a guide to results of excision of the hip, because they have not been treated from the point of view of obtaining a functionally good position afterwards; and personally, I do excision, and treat them afterwards in full abduction, and later put on a caliper splint to take the weight off the limb.

Mr. Fairbank: My experience of the operative treatment of osteoarthritis of the hip is so small that I have not much to say, but, from seeing results in my few cases, and in other people's, I am glad to hear

so many inclined to put forward the benefit derived from excision of the hip, which seems to give the best results if you are going to get any movement of the hip at all. It has been my belief that the result after attempting osteoplasty, depends very much more on the amount of bone removed than on anything which the surgeon puts between the bones, and also, perhaps, on the after-treatment as well. Unless you leave a sufficient interval between the bones, you will not get a good result, no matter what you put in between.

I am disappointed that we have not heard more about the early, non-operative treatment, because it seems to me that there are very few cases you can operate upon: either they are not severe enough, or they are too old and severe, and in the latter you cannot run the risk of opening the hip-joint, which is, as other speakers have mentioned, a very severe operation. With regard to treatment without operation, it seems to me the pain is caused by one of two things: either the movement of the hip-joint or the weight-bearing. In one instance, the pain is not great, except when the limb is walked on, while in other cases any movement causes agonizing pain, even to the extent of interfering very materially with sleep. In such cases, I think, one has always to try to ascertain, before ordering any apparatus, exactly which of these two—movement or weight-bearing—inconveniences the patient more. In a recent case, the patient was unable to sleep for longer than a few minutes at a time, being repeatedly disturbed by slight movements of the hip-joint. I abducted the hip first, under an anaesthetic, and then I obtained a plaster model, and had a leather support made, coming down to the knee. That immobilized the hip-joint. In addition, I had a walking caliper splint made, which fitted into little D-shaped sockets on the leather splint, so that the former could be put on for walking purposes. When in bed at night, she wears the leather splint without the caliper. The result has been very gratifying. She is very greatly relieved, and her general health has improved enormously.

Another point is this: when you abduct the hip-joint and endeavor to retain it in abduction and then put on a caliper splint, you must thicken the opposite heel. It is difficult to maintain abduction unless you increase the length of the other leg.

The President (Sir Robert Jones): This subject has been extraordinarily well covered, both by the very interesting introduction on the part of Mr. Aitken, and by what we have heard from subsequent speakers.

I have very little which is new to add to this debate. Most of you know what my practice has been with regard to these rheumatoid conditions, but, in spite of many successes, I have experienced almost every variety of difficulty and disappointment which has been alluded to and described so graphically by speakers. There is that type of case which Mr. Mitchell so very well described—the man of about 50 to 55 years of age, who has pain in his hip, not enough to justify operation, nor to do anything drastic. I think our inventive faculty is severely exercised when dealing with that type of case. It is much easier to deal with the more advanced and acute, for the discomfort warrants drastic treatment.

But there is one kind of case which has not been referred to much today, but which we often meet with, and that is the monarticular rheumatoid arthritis, with sharp stalactytes about the joint. Such a case may remain five or six years, hardly getting any worse, but complaining very greatly of the pain and the inconvenience of limited movement. In a very large number of such cases an anæsthetic and very gentle stretching and breaking down of adhesions gives the patient very great relief. That relief does not necessarily last a very long time, though sometimes it does. I remember one case in which the patient had been bad seven or eight years, and, under an anæsthetic, we carefully broke down adhesions, and for four or five years afterwards he was quite easy and comfortable, only complaining occasionally of pain. Such relief is due to the fact that in connection with the inflammatory changes which go on at the edges of the joint, there are a large number of adhesions, which are very painful.

The operation of cheilotomy was referred to in Mr. Elmslie's admirable address. I have had some experience of this operation: I remember helping Mr. Sampson Handley in one such case. In that instance, the patient was getting distinctly worse, with sharp, big excrescences on the posterior part of the head of the femur, and their removal certainly gave him much relief. I remember, also, another case—that of a man who was a painter and had to climb ladders, in spite of much inconvenience and pain. I tried to break down his adhesions, but without lasting effect; and, finally, I took away two large masses at the back of the joint, and their removal enabled him to climb ladders without any inconvenience. This operation is best performed by displacing the trochanter, for in this way you get a good view of the osteophytes. The difficulty which is experienced by everybody is that of dealing with the masses which occur below the joint. As a rule, those masses are not the ones which cause the greatest disability.

Much has been said about arthrodesing or ankylosing these joints. I have ankylosed a good number, but I have had the same difficulty, especially early on, in getting bony union. There is a tendency for ankylosis not to be complete. They have not been patients in whom one has been justified in turning out the head of the bone and making a complete operation. I have had cases, in younger people, in whom I have experienced no difficulty, in whom I could turn the head of the bone out completely and remove the cartilage from the head of the femur and acetabulum. In such cases there is no difficulty, but that operation should never be done in the case of aged persons. As Mr. Hey Groves and others have said, the operation of turning out the head of the femur and removing all the cartilage in a man over sixty, is a very grave procedure, and one which, I think, in the present state of knowledge, is rarely justifiable. In such cases, even if the patient survives, he will have had a great shock, and one is not so likely to get an ankylosis as in the case of persons with younger bones.

Then there is the problem presented in the case of the patient sixty years old who has an acute and persistent pain, and who is willing to leave himself unreservedly in an operator's hands if a promise of relief is given. In such a case, an operation can, as a rule, be performed, especially if the person is thin, with scarcely any shock. I have often described the operation, which consists of displacing the great trochanter and, having previously removed a large piece of the neck, nailing it to that part of the neck attached to the head. In my experience, turning out the head of the bone in an old person is accompanied by considerable shock, to be avoided if possible. I would therefore advise that in the case of the old person, any operation which is done should be one in which you leave the head of the bone in the acetabulum. Not long ago, I told a gentleman, aged 60, that I thought an operation might benefit him. Having said that, however, I got rather timid, and I rested him for awhile and tried to abduct his hip, doing many things, indeed, rather than operate. I was, however, sent for by the patient's friends who said he was prepared to take any risk in the hope of relief. I asked a distinguished physician whether he would see the patient, hoping that he would discountenance operation, for the old gentleman had a blue, unhealthy face, and seemed a most uninviting case. The physician, who was an optimist, went to see him, and gave me a very good report—therefore, I had to operate. The operation I chose was that of nailing the trochanter to the acetabulum, and it scarcely took twenty minutes. The next day, the patient was smoking a cigarette and thinking a miracle had occurred in his case. You cannot lay down a strict

rule. If the man is old, you must judge as to the value of life to him. The pain in many is so great that some prefer to die rather than to continue life in perpetual pain.

I have had considerable experience of the operation of excision, both in old dislocation and for rheumatoid arthritis. In old dislocation the head being already displaced, there is no shock, as there is in rheumatoid arthritis.

In the case of the younger men, the removal of the head of the bone, leaving a fairly long neck, and covering the neck with capsule, makes a very good operation indeed, and the results of it are very good. Again, as Mr. Tubby said, the after-treatment must be of such a kind that all weight must be removed for a considerable time from the bone. Mr. Hey Groves mentions that one of the drawbacks of the operation is that there is no stability—the femur is too much upwards. But this is no great disability when you remember you have saved them from a good deal of misery and they can walk without inconvenience and pain.

I recently saw a case in which excision had been done for a man aged forty-five. He had a rheumatoid joint which was septic, and the x-ray view showed it was more the type of pseudo-coxitis, which Mr. Elmslie alluded to, and whose theories I can confirm from my own experience. I have seen many cases of rheumatoid arthritis in which the condition is more suggestive of a changed head of the bone, very much the type of change which occurs in the young, and which our distinguished visitor, Dr. Calvé, has referred to. It has been said that the danger is of our failing to bring about movement, whatever operation is practised. The only way to prevent this is to remove plenty of bone, and the orthopædic surgeon, by training and practice, is in a better position to secure motion to the joint by his knowledge of the principles of after-treatment than is the average surgeon.

Mr. Alwyn Smith drew attention to a very tragic case. Strangely enough, when I was in Chicago last year, I was asked to see this case, so I know its subsequent history. An operation had been performed at the clinic, but, unfortunately, the hip again suppurated. I advised a Fabian policy for some months, and then an operation to produce movement by removing about an inch of femur just below the trochanter.

I should advise surgeons to be careful not to urge operations for hip trouble on the old, for one cannot promise, with any certainty, a precise result. One should explain to the patient the dangers of failure, erring on the side of pessimism; and when any procedure is considered, let the element of shock be weighed with care.

Mr. Aitken (in reply): The course which the discussion has taken has left very little for me to say. I am glad the President has referred to the early treatment by manipulation. In opening, I omitted to say that I think movement under an anæsthetic, which he recommends (I have seen many cases with him) is most suited to cases in which there is not complete fixation, where there is a very considerable adduction, and where the thrust along the shaft of the femur by the body-weight on that hip is outwards, the characteristic feature being that those patients have pain when walking, they get stiff after walking, and they will often tell you that they are stiff in the morning on rising. In the morning, they can walk a certain distance and get better for a time, and then they become worse again as the strain comes on these fibrous adhesions. But Sir Robert omitted to say he sometimes uses this very gentle manipulation of the hip which he practises to such an extent that he fractures the projecting osteophytic outgrowths, getting thereby a greater freedom of movement. If you can secure enough clearance to get the hip abducted, to get a direct thrust, the result is satisfactory. Those cases, after being abducted and manipulated, are not fixed. The day after the manipulation movement is commenced, if possible, the patient should be got out of bed to stand with legs apart and practise abduction. If the patient has too much pain forty-eight hours afterwards to allow that to be done, the indication is that movement must be abandoned and the hip must be fixed in plaster, in an abducted position.

With regard to Sir Robert Jones' gentle methods, I adopted them in the case of a lady of 63 years, who complained of the flexion, adduction, and extreme rotation of the thigh. I got abduction satisfactorily, and easier than I expected to. I got the flexion corrected, but the foot was still turned out, and I knew she would not be contented until I got the foot turned in. I got hold of the thigh by the knee, and was working away with my hands, when a snap occurred, and I found a spiral fracture of the shaft, immediately above the knee. The result was ultimately satisfactory, because the lady can flex her knee backwards and forwards, instead of sideways. I do not recommend the method, it is too anxious for the surgeon. It is interesting to note free excision is apparently considered more satisfactory than an attempt at formal arthroplasty, so far as we have gone in this debate. In my Cripple Hospital, I get a considerable number of pathological dislocations of the hips to deal with, that is to say, acute septic hips where the hips were allowed to fall backwards while the patient was in bed. In some of them, after a sufficiently long period after the sepsis has subsided, it is possible to re-

move the head of the bone and reduce the neck, as if it were a congenital dislocation, into the region of the acetabulum, putting them into an abduction splint. One then gets a movable hip, which is often wonderfully stable, with very little tendency to get shortening of the limb afterwards, provided, first, the position of abduction is maintained for a sufficiently long time, and second, the patient walks in a caliper splint for many months before attempting to walk without any supporting apparatus.

Correspondence

Bone Sarcoma.

November 22, 1921.

To the Editor:

Your correspondent regrets not having had the opportunity of discussing the excellent paper of Doctors Greenough, Simmons and Harmer, on Bone Sarcoma, read at the last meeting of the American Orthopedic Association and published in the November issue of the *Journal of Orthopædic Surgery.*

In so far as true bone sarcomata are concerned, the conclusions reached are clear, instructive, and important.

Ewing's classification of osteogenetic sarcomata must be regarded as a decided step in advance, and of special value to the surgeon, in that it simplifies our conception of the malignant processes encountered in bone.

A study of the second group of cases is less clear. It is rather difficult to avoid the impression that the authors are not altogether consistent when they report and classify twelve cases as being benign giant-cell sarcomata, or tumors, in one part of the paper, and in another state that the giant-cells of the foreign-body type

> "are of practically no significance from the tumor point of view, however much they may impress themselves in the microscopic section of the tissue."

Your correspondent has stressed this latter fact on many occasions, in numerous papers published on the subject during the last decade. The appellation of "giant-cell" to these lesions seems to be as much out of place as the term "rheumatism" is to the arthritides. Long usage of the term should not be an excuse for continuing the misnomer.

If we wish to be scientifically accurate, it is impossible to regard these lesions as "giant-cell" tumors. In so far as our present-day knowledge goes, the giant-cells have nothing in common with tumor formation. Giant-cell distribution is never uniform in these lesions, and may not be said to dominate the entire mass. Some areas may contain an abundance of these cells, while other areas in the mass have few, or even none.

The tissue the process exhibits, when examined in the gross, gives all the criteria we possess of proliferating granulation regenerative structure, frequently containing areas showing metaplasia. Microscopic studies of the tissue confirm this evidence of an inflammation.

Masses of granulation tissue occurring in other connective tissues in the body are not generally regarded as tumors. It would therefore seem that they should not be so regarded when found in bone. Should a blastoma arise in the mass, the type tissue it represents is the one to be recorded.

If the cellular pathology, as well as the gross living pathology, is negative for autonomous growth, there seems to be no escape from the conclu-

sion that the lesion must be described and regarded as an osteomyelitis. Usually, at operative interference, the process is found to be extremely vascular. The term, hemorrhagic osteomyelitis, is used in describing such cases. The lesion may readily be produced by aseptic traumatic insult to bone.

A personal study of forty cases (exclusive of the bones of the skull, face or spine) that have been observed coincides, in their clinical pictures, in most respects, with the findings of the authors of the paper. In our series trauma appears to have been the etiologic factor in 75 per cent. of cases.

In no instance where ossification has not occurred, has there been penetration of the epiphyseal cartilage. Indeed, it has been one of our diagnostic aids from the x-ray viewpoint, that if epiphyseal cartilage was penetrated, a diagnosis of suppurative infection might safely be made, providing other evidences of malignancy were absent. Where ossification had occurred, epiphyseal ends of bone were commonly involved.

The age of our patients has varied from 18 months to 63 years. A majority of the lesions have occurred in the lower extremities. Operations were performed upon 27 patients; in only one of the number was the operation more severe than curetting. The sizes of the lesions ranged from those of a lima bean, cherry, egg, and orange, to a grapefruit.

George Barrie.

New York City.

News Notes

The British Orthopædic Association has chosen the following officers for the coming year:

Sir Robert Jones, President; Mr. H. A. T. Fairbank, Vice-President; Mr. W. R. Bristow, Treasurer; Mr. R. C. Elmslie, Secretary; Mr. Harry Platt, Editorial Secretary.

Government Need for Workers in Rehabilitation.

Washington, D. C., December, 1921.

The United States Civil Service Commission states that there is urgent need for reconstruction assistants and aides in physiotherapy and occupational therapy, trained nurses, and physicians, to serve in hospitals and other establishments of the United States Public Health Service and the Veterans' Bureau, in the care and rehabilitation of men injured in the World War. The Commission has announced that it will receive applications for these positions until further notice. The applicants will not be given written scholastic tests, but will be rated upon their education, training, experience, and physical ability.

The Commission points out the importance of filling these positions promptly, with the best qualified workers available.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the Secretary of the Local Board of Civil Service Examiners at the postoffice or customhouse in any city.

British Orthopædic Association. Meeting at Oswestry.

A clinical meeting of the British Orthopædic Association was held at the Shropshire Orthopædic Hospital, Oswestry, on September 24th, 1921. This Hospital, formerly situated at Baschurch, and so well known as the pioneer among country orthopædic hospitals, has recently removed to larger premises at Oswestry. Although the staff has been considerably increased, Miss Hunt, with whose name the hospital has always been identified in the past, remains the chief organizer.

At the meeting on Friday, Sir Robert Jones demonstrated a number of cases in the wards, the following being a few of those which were of special interest:—

(1) Very severe rickety deformities of the lower limbs, with extreme bowing of the shafts of the femora and tibiæ, which have been treated by osteotomies in the middle of these bones, and after application of caliper walking instruments. Sir Robert emphasized the necessity for preliminary treatment by general hygiene and by moulding the badly curved bones by fixation upon a frame, the objection to correcting an anterior curvature of the tibiæ fully, because in so doing one is very apt to produce an apparent genu recurvatum, and finally the necessity for the use of walking splints for a considerable period after osteotomies, to prevent recurrence.

(2) A girl of 12, with paralytic dislocation of the right hip, the limb muscles being fairly good and practically all active. The shortening of the limb was 4¾ inches. Sir Robert Jones discussed the possibility of lengthening the femur in such a case by stepping operation, and stated that he had secured as much as three inches of additional length in this way. He recounted a story of how an operation in which he shortened the sound limb of a patient in order to render the two limbs approximately equal in length. proved so successful as to lead to his being offered the post of surgeon to the Manchester Ship Canal at the time when it was being built.

(3) A girl of 17, with old-standing infantile paralysis, involving complete loss of the deltoid muscle, in which an arthrodesis of the shoulder-joints, performed four years before, had resulted in a very great improvement of function, so that the arm was useful for all purposes below the level of the ear. The warning was given against arthrodesing the shoulder in an adult in too great abduction, so that the patient is unable afterwards to bring the arm to the side. a very ugly deformity remaining.

(4) A case of bi-lateral congenital dislocation of the hips in a girl of 13, with very severe lordosis and limitation of abduction. X-rays showed well marked, false acetabula, and treatment by osteotomy to secure abduction and lessen lordosis, was suggested. Sir Robert referred to a case of his in a woman of 32, with congenital dislocation, who walked extremely badly, with adducted hips, like the very worst type of coxa vara. She was treated first by a forcible abduction, which produced a temporary paralysis of the sciatic nerve; then a wedge-shaped osteotomy was done, which resulted in a very great improvement, so that she was able to walk well. Sir Robert had several times shown her to visiting surgeons, but upon the last occasion that she was shown, she had been emphatic in stating that the chief improvement which had taken place in her condition occurred after she had become a Christian Scientist!

(5) A boy with infantile paralysis of the left upper limb, in whom with a flail shoulder and elbow, the hand had been quite good. He had been treated by arthrodesis of the shoulder and by the stitching together of skin flaps in front of the elbow, so as to maintain flexion of this joint. Very good power and active flexion of the elbow had become established, and the skin flaps had greatly stretched out, so that at the present time the elbow is actively useful, and in front of it is a tubular portion of skin attached to the arm and forearm, with a tunnel between it and the elbow.

Following this, Mr. Naughton Dunn described an operation which he is at present performing for severely paralyzed feet. He pointed out that in these cases there is a tendency to go on for years correcting deformity as it supervenes, and using instrumental support, and that the factors of unequal balance of muscles and of the body-weight action upon lax joints cause a constant tendency to, or progress of, deformity. The object of his operation is to reduce mobility by joint fixation, so that the tarsal joints are abolished and the foot moves at the ankle as one structure at a single hinged joint. The muscles remaining can then be re-distributed, so that they act, as before, as flexors or extensors of this joint. The operation, consisting of excision of the scaphoid and of the articular surface of the os calcis, astragalus, cuneiforms and cuboid, and the displacement of the foot backwards beneath the astragalus, will be described in detail by Mr. Dunn. A large number of illustrative cases were shown to the meeting.

Mr. Girdlestone explained the general principles and details of the methods of treatment of spinal caries used in the Hospital, discussing the period required before the patient could be said to be cured. He concluded that tests of mobility of the spine are useless, and that, apart from the general condition of the patient and the absence of abscess, the best test that a patient is in a safe condition and may be allowed to get up is an x-ray of the spine, which demonstrates that there is a sound bone scar at the site of the disease. Mr. Girdlestone showed a number of cases in which the spine had been fixed by a bone graft or by a modification of Hibbs' method.

Mr. Macrae Aitken demonstrated a correction in plaster of a case of kypholordosis and a case of scoliosis, using Abbott's frame, and a demonstration was held in the gymnasium, illustrating the methods of treatment of scoliosis by gymnastic exercises adopted in the Hospital. The most interesting feature in these exercises was the use of deep breathing in positions which tended to fix the convex side of the chest as a means of rotating the vertebræ. That rotation can be secured by such breathing movements could be clearly seen in the children shown.

In the afternoon, visits were paid to some of the After-care Centres. A number of these have been established throughout the county of Shropshire. The children under observation or treatment attend one day in each week—preferably on market day. They are seen weekly by the visiting nurse and once a month by a medical officer from the Orthopædic Hospital. Records, including photographs and plaster casts, are kept at the After-care Centres, measurements for splints and appliances made, and simple plaster applications made at these centres.

On September 25th, a series of operations was performed, namely, (1) Albee's operation for spinal caries, by Mr. Girdlestone; (2) osteotomy for malunion of fracture of the femur, by Mr. Aitken; (3) stabilizing operation upon a paralyzed foot, by Mr. Dunn; (4) correction of a club-foot in a child of seven, with the wrench, by Sir Robert Jones; (5) Soutter's operation for displacement of the anterior superior spine of the ilium as a means of correction of flexion of the hip, by Mr. Noble.

The meeting was attended by about fifty members and visitors.

Interurban Orthopædic Club Meeting.

The meeting of the Interurban Orthopædic Club was held in Toronto, on December 2d and 3d. The program was as follows:

FRIDAY, DECEMBER 2nd, 1921
HOSPITAL FOR SICK CHILDREN

9.00 A.M. R. I. HARRIS.

A case of Volkmann's Contracture, in which no splints or bandages had been applied.

Erb's Palsy.

D. E. ROBERTSON.

A case of sarcoma of the scapula.

A case of sarcoma of the skull.

Fragilitas Ossium.
Cases of an unknown epiphyseal disease.
Diamond bone grafts.

BRUCE ROBERTSON.

Pedunculated skin grafts.
An undescribed condition of condensing osteitis of the body of a vertebra, simulating Pott's Disease, resembling Köhler's disease of the navicular bone.
Rickets extraordinary.
Exsanguination combined with blood transfusion in the treatment of toxaemias.
Infantile paralysis involving the neck.

A. B. LEMESURIER.

Comparison of the methods of treating fractures of the femur in children.

C. L. STARR.

The treatment of tuberculous abscess.
An unusual tumour of the forearm.

12.30 P.M.

Luncheon at Hospital for Sick Children.

1.15 P.M.

Executive Session.

2.00 P.M.

CHRISTIE STREET HOSPITAL—SOLDIERS.

Inspection of sunlight treatment of tuberculosis of bones and joints.

C. L. STARR.

Unusual cases of bone tuberculosis.
Bone grafts.
Tendon Transfers.

R. I. HARRIS.

Sunlight and alpine lamp treatment of tuberculosis.
Granuloma Inguinale.
Difficulties and failures in the treatment of non-union of the tibia.
Cases illustrating the results of nerve sutures.

W. E. GALLIE AND A. B. LEMESURIER.

Operation for rupture of ligament of patella.

A. B. LEMESURIER.

Unusual amputation cases.

4.45 P.M.

Tea with the Nurses.

7.00 P.M.

Resuscitation at the homes of Dr. Starr, Dr. D. E. Robertson and Dr. Gallie.

7.30 P.M.

Dinner at York Club.

SATURDAY, DECEMBER 3rd, 1921
HOSPITAL FOR SICK CHILDREN.

9.00 A.M. W. E. GALLIE.

Old tendon fixations.

An operation for infantile paralysis involving the shoulder.

Living sutures in the treatment of ptosis.

Living sutures in the treatment of hernia.

An operation for the cure of rupture of the ligamentum patellae.

An operation for the cure of lateral dislocation of the patella.

An operation for the relief of non-union of the patella.

The prevention of forward displacement of the foot following astragalectomy.

Fractures in bone grafts.

TORONTO GENERAL HOSPITAL.

11.00 A.M. C. L. STARR.

Spasmodic torticollis.

Sarcomas of femur and fibula.

N. S. SHENSTONE.

An extraordinary case of bone transplantation.

G. E. WILSON.

Treatment of compound fracture of the humerus.

G. E. RICHARDS.

Radium and high voltage x-ray in treatment of tumours of bone.

1.00 P.M.

Luncheon at Hart House.

MEDICAL BUILDING,

DEPARTMENT OF PHYSIOLOGY.

2.00 P.M. J. J. R. MACLEOD.

Experimental study of the influence of local applications of heat and cold on the deep temperatures.

N. B. TAYLOR.

Changes in peripheral blood-flow, resulting from massage, movements, etc.

2.00 P.M. J. J. R. MACLEOD.

Experimental study of the influence of massage and electrical stimulation of the muscles in lesions of the lower neurone.

The case of Volkmann's Contracture, demonstrated by Harris, was interesting, in that the typical symptom complex appeared in this case without there having been the slightest question of constriction from splints, in a case of fracture of the elbow, associated with a large haematoma. Medico-legally the question is often raised as to whether true Volkmann's Contracture can occur from the trauma alone without the possibility of too tight splinting as a cause of lesion. This case seems to demonstrate beyond cavil that such typical symptoms can occur from injury alone.

Dr. Starr presented data to show that the treatment of tuberculous abscesses by early free incision at the least dependent portion of the abscess through healthy tissue, the curetting of the sac, and the swabbing out with gauze, results in a permanent closure in a great majority of cases. The method has been continued for over ten years at the Hospital for Sick Children and is still being pursued with entire satisfaction by members of the Staff.

Dr. Harris's demonstration of the value of sunlight treatment in tuberculosis of bones and joints in adult soldiers was very convincing and seemed to prove beyond question the great value of this treatment, perhaps supplemented during the winter months by alpine lamp therapy. It is his opinion that while the alpine lamp may be an adjuvant, its comparative value with natural sunlight was much less.

Dr. Starr also demonstrated many cases where the diamond-shaped bone graft had been employed with great success. The cone-like ends of the host bone on each side of the graft are split with a saw, flared with an osteotome, and the diamond bone graft inserted, the greatest thickness of the graft coming at the center of the gap in the place where strength is most needed. Dr. Starr also demonstrated many cases of successful tendon transplantation for irreparable injury to the musculospiral nerve.

The operation by Dr. Gallie and Dr. LeMesurier for rupture of the ligament of the patella convincingly demonstrated the value of the use of living sutures. A portion of the tendo Achillis and the plantaris tendon, inserted into the patella and tibial tubercle by firm bony fixation, seemed to repair in a completely satisfactory manner the ruptured ligament.

At the dinner on Friday evening there was a long discussion of the methods of teaching Orthopædic Surgery in the medical schools. A committee had been appointed at a previous meeting, consisting of Dr. W. E. Gallie, Dr. W. S. Baer, and Dr. R. B. Osgood. Outlines of orthopædic teaching at present in vogue in all the principal medical schools in the country had been received in response to a questionnaire sent out by this committee. Expressions of opinion from the leading professors in orthopædic surgery were also reviewed. As concrete suggestions there seems to be a unanimity of opinion in the Club that in the second and third years the teaching of orthopædic surgery should be as closely connected with general surgery as possible, perhaps even not being taught as a separate subject, but as a definite part of general surgery, clinical and didactic exercises, these exercises given in conjunction with the courses and clinics in general surgery by men specially trained in extremity and spinal surgery; that in the fourth year there might well be a clinico-didactic course covering the subjects of congenital malformations, static deformities, old bone and joint deformities, bodily mechanics, the mechanics of function, etc., and certain other conditions which do not, as a rule, come within the purview of the general surgeon.

On Saturday morning Dr. Gallie, in the opinion of the Club, convincingly demonstrated the permanent value of his method of tendon fixation

and use of living sutures of fascia and tendon by an exhibition of many patients upon whom operations had been performed.

A demonstration of the apparently curative value of high voltage roentgen ray radiation in certain very unusual and extensive bone neoplasms was presented by Dr. G. E. Richards, roentgenologist of the Toronto Hospital.

Professor MacLeod's report of the experimental study of the influence of local applications of heat and cold on the temperatures of deep structures was extremely interesting. It was evident that the temperature of most deeper structures could be influenced by the application of heat and cold externally. His experimental evidence also seemed to show that in cases of paralysis due to nerve injury electricity and even massage was of apparently little value in hastening regeneration of muscle power.

Current Orthopaedic Literature

BONE OPERATIONS

Certain Fundamental Laws Underlying Surgical Use of the Bone Graft. F. H. Albee. *Annals of Surgery*, Aug., 1921, p. 196.

The author enumerates various methods which are being used for the treatment of pseudarthrosis, such as injection of blood into the site of the lesion, Bier's hyperaemia, deep massage to promote healthy circulation, and fixation of the fragments by means of metal appliances. During the past twelve years he has studied many cases in which one or more of the above forms of treatment have been carried out, and, as a result, he believes that all such non-operative procedures, and particularly operative method involving the introduction of metal, have no place in the consideration of the proper treatment of pseudarthrosis.

The bone graft operation is the only method offering a solution of the problem, and the inlay technique is the most trustworthy one. In order that the fundamental laws pertaining to tissue transplantation be fulfilled, the graft must consist of all four layers, namely, periosteum, compact bone, endosteum and marrow.

The osteoperiosteal graft fails because of its lack of rigid continuity, and is, therefore, incapable of furnishing fixation. By nature of its removal it cannot be a complete osteogenetic unit. Since it does not possess rigid continuity, and is, therefore, incapable of bearing mechanical stress, its metabolism and bone growth are not influenced by that powerful stimulus of withstanding mechanical stress with fracturing. In place of the osteoperiosteal graft the author uses his so-called "sliver graft" which consists of a thin slice of bone containing all layers.

The author advises that before deciding to operate on cases of pseudarthrosis, one should resort to rough manipulation of the fragments, deep massage, possibly a two-stage operation, in order to avoid a recrudescence in cases which have been infected. Other points which are essential to success are that the operation should be of short duration and that the operator should plan his incision through the skin so that it does not overlie the bed of the graft. The graft should be long enough if possible to extend into each fragment for a distance of five cm., and it should always extend beyond the eburnated end of the fragments. The graft should be held in place by absorbable sutures.

The author emphasizes the importance of post-operative fixation and he advocates a plaster of Paris spica in order to immobilize both shoulder and elbow. He uses absorbable skin sutures to avoid disturbance of fixation.—*LeRoy C. Abbott, Ann Arbor, Michigan.*

FUNCTION IN RELATION TO TRANSPLANTATION OF BONE. S. L. Haas. *Annals of Surgery*, Sept., 1921, p. 425.

In order to determine the rôle played by function in the growth of bone independently of all other factors, the author performed a series of experiments on dogs. In one of the series of experiments he removed the first metatarsal bone and replaced it in its normal bed, and in the second series he removed the metatarsal bone and transplanted it into the deep muscles of the back. Function is then established by allowing the dogs to run about and observations were made at periods varying from 48 days to three years. The conclusions arrived at were:

1. Function exerts definite influence on the viability of a transplanted bone.
2. Free bone transplants when subject to stimulation of normal function undergo a slower degeneration than similar transplants that are not under such functional influence.
3. Bone transplants from old animals are more resistant to absorption and degenerative processes than those of young animals.
4. From a practical standpoint the institution of function at the earliest possible moment is advisable in order to aid in insuring success in the operation involving transplantation of bone, but this early function should not be established if it jeopardizes the possibility of bony union between the transplant and the host, a condition that is essential and of prime importance.—*LeRoy C. Abbott, Ann Arbor, Mich.*

THE PLASTIC SUBSTITUTION OF THE THUMB, ESPECIALLY IN CASES OF LOSS OF THE ENTIRE THUMB AND METACARPAL. Perthes. *Arch. Orch. und Unfallchir.*, xix, 2, July, 1921.

In a short review of the subject, the author mentions the two methods of Nicoladoni. In the first method, the thumb is reconstructed by means of pedicled flaps from the skin of the abdomen, into which a piece of the tibia, a phalanx, or a piece of a resected rib, is implanted.

The second method supplants the thumb by the toe, usually the big toe of the contralateral foot.

Another method is the formation of cleft, using the preserved first metacarpus as a substitute. No mention is made in this connection of the Italian phalangization method (Putti).

Finger exchange is another method, used first by Luksch in 1908 and later perfected by Spitzy. (Here also notable achievements of technique, especially the work of Joyce and others, is left unmentioned.) Another method, little known and little applied, is the torsion of remaining fingers by osteotomy of the 2nd and 5th metacarpals, by which the index and little fingers are twisted so that their respective volar surfaces approach each other. In the thumb plasty concerning cases with preserved first metacarpal, the author uses the method of phalangization, or cleft method as he calls it.

Several cases are reported and good results demonstrated in photographs.

In cases of loss of both thumb and its metacarpal, of which the author reports three, a phalangization of the 2nd metacarpal is carried out by incisions running

up on the dorsal and volar surface in such a manner as to furnish sufficient skin for the new thumb, while the covering of the surface toward the third metacarpal is taken care of by a pedunculated flap from the chest. An important point is torsion of the metacarpal which is obtained by osteotomy. Careful use is made of the preserved tendons of the fingers, the flexors being used as adductors and the extensors as abductors. The operation can be carried out in one sitting.

In all three cases, of total loss of thumb and metacarpal, the results were so encouraging that the author recommends the procedure as routine for similar defects. He considers this method superior not only to the first Nicoladoni method with pedunculated flap, in which no movable thumb is obtained, but also superior to his second method of supplanting the missing thumb by the big toe.—*A. Steindler, Iowa City, Ia.*

Results of the Supra-Condylar Osteotomy in Flexion Contractures of the Knee Joint. L. Aubry. *Zeit. orth. Chir.*, Vol. 4; Nos. 1, 2; April, 1921.

Ollier was the first who applied supra-condylar osteotomy for the correction of flexion contractures of the knee joint.

The number of supra-condylar osteotomies carried out at the Munich Orthopedic Clinic of Lange in the last thirteen years amounted to 104. Only in 40 cases was it possible to check up upon the result of the operation. The largest group, of ankylosis and contracture of the knee, is represented by tuberculosis (63 cases); this is followed by poliomyelitis (24 cases).

The time between the beginning of the disease and operation varied between one and 20 years, the largest number falling between two and eight years. All degrees of flexion contracture were represented.

Before the operation, the ability to walk was, in the overwhelming majority of cases, poor. A large number walked on crutches and seven walked on their hands.

The osteotomy was carried out in different ways, as straight, curved, or V-shaped osteotomy. In a large number of cases, a V-shaped piece was removed in order to facilitate correction.

Tenotomies of the flexor muscles preparatory to the osteotomy were not carried out.

The after-treatment consisted in the usual application of a plaster cast, including ankle and hip joints, and remaining from four to six weeks. Then a lighter cast was applied, the patients being allowed to walk after the sixth week. Complete weight-bearing was gradually permitted before the completion of one year.

Regarding the final results, reports were on hand on 94 patients. In 63 operations the position of 180° to 170° remained. In 16, a flexion of from 170° to 160° developed, and 10 went below 160°.

In four patients, the operation had to be repeated because of the recurrence of the flexion contracture. These were all cases of tuberculous knee disease.

The ability to walk was improved in all cases and, in the great majority of cases, considerably so.

Of 40 cases in which the late results were ascertained, 22 cases were observed not less than two years after the operation; in the remainder the periods varied

from three months to two years. Of the 40 cases, 29 were tuberculous. Of these, 14 showed complete extension, 6 slight, and 9 distinct flexion.

In nine cases of poliomyelitic contracture with 11 operations, the extension remained completely in 10 operations. Twenty-two of the 40 cases walked with braces and 18 without.

Of the 22 cases examined two years or more after operation, the extension was completely preserved in 16; flexion of more than 170° secured in six cases. There is a preponderance of tuberculosis cases among those which show a tendency to recurrence.

Conclusions: The supracondylar osteotomy in flexion contracture of the knee-joint gives, in the vast majority of cases, good results. Recurrences were observed only in 4% of the cases. The operative results were preserved by the wearing of braces for several years after the operation, and the author believes that this precaution is absolutely necessary. The osteotomy should be carried out as close as possible above the condyles. A correction after osteotomy is not altogether accomplished at the place of bone operation, but also partly intra-articular by compression of the epiphyses. There is a danger of spur formation by sliding of the fragments. The external configuration as well as the internal architecture of the bone becomes greatly changed by adaptive processes consisting in apposition and absorption. Entirely new trabeculae develop in the interior of the bones.—*A. Steindler, Iowa City, Iowa.*

CINEPLASTIC SURGERY OF THE UPPER EXTREMITY. F. M. Cadenat. *Revue d'Orthopédie*, January, 1921.

This is a review of the cineplastic literature to date. Historical:

The author mentions, first, efforts of Vanghetti, 1896-1898, followed in 1900 by Ceci; in Italy; also those of de Francesco, Codivilla, Pieri, Putti, Delitala, and others; in Germany, Wreden, Sauerbruch, Krukenberg; in France the method has been long ignored, the judgment in 1917 being still adverse to this method.

Principles of cinematization: The method may be carried out by *(a)* loop, *(b)* club formation. The loop may be terminal, that is, at the extremity of the stump or lateral, that is, at the side of the stump. The lateral loop may be formed by simply tunneling the muscle masses and covering the tunnel with skin; intermuscular canalization. The club is a part of the stump separated from the rest by a constriction or a ring. In order to obtain it, one may proceed in different fashion.. A description of the different technique is given as follows: (1) cineplasties with terminal loop; (*a*) single loop, technique of Putti. Double parallel incision; elevation of the bi-pedicled skin flap in the middle and deflection of the lateral flaps.

Sub-periosteal resection of 3 cm.: of the forearm bones; in rolling of the bi-pedicled flap and by suturing its free ends together. (*b*) Technique of Ceci. Circular incision of skin and all soft parts, 1 cm. above carpus. Double longitudinal incision at the internal and external border of forearm starting from the circular incision and reaching 10 cm. upward. Dissection of the two musculo-cutaneous flaps in front and in back and freeing of the bone. Sectioning of the two forearm bones at the base of the two flaps. In rolling of the two flaps around the tendons, constructing in this way two slings, one

anterior and one posterior, which contain the flexor and extensor tendons, respectively.

Double Loop: Technique of Ceci. The homologous tendons are sutured together: flexors with flexors and extensors with extensors, forming in this way two loops of antagonistic action. Circular incision of the skin at lower fourth of the forearm. Section of the tendons. Double longitudinal incision at internal and external border reaching 15 cm. upward. Dissection of the two skin flaps and dissection of the two musculo-tendinous flaps, sectioning of the two bones at the base of the flaps; suturing of the two flaps, the corresponding tendons being sewed together, extensors to extensors and flexors to flexors. Then two button-holes are cut of 3 cm. in length. These have a vertical direction, and are situated one over the other in median line. The skin flap is then turned over a transverse axis in such a way that the two corresponding button-holes cover each other. Then the skin flaps are sutured and the edges of the button-holes also.

Lateral Loop: Technique of Delitala-Pellegrini. The muscles which are to be used for the establishment of the lateral loop are exposed at the level of two transverse incisions parallel to each other. At the extremity of the stump, the tendons are now liberated and sectioned. They are then pulled out through the inferior transverse incision. The skin bridge is rolled by sewing its free margins together and the ends of the tendons are slung over it and fastened in a loop to the muscular bellies. Then the two far edges of the two parallel skin incisions are fastened to each other.

2. Formation of a Club: *(a)* Muscle club: transverse incision of the extremity of the stump, formation of two flaps by U-shaped incision and dissection of the anterior and posterior flap. Section of the bone at the base of the flap. The two flaps are united forming a club (technique of Arana). *(b)* Osteomuscular club. (Technique of de Francesco.) Two incisions of 5 cm. length at the inner or outer side of the limb. Resection of 3 cm. of radius and ulna leaving two bony fragments of 2 cm. each at the extremity of the stump. Interposition of muscle tissue to produce a pseudo-arthrosis. Suture of the two lateral skin wounds.

3. Cineplastic amputations on the principle of alternating motors. These are juxta-articular amputations. Cineplastic amputation of the elbow: In a lesion necessitating an amputation of the forearm, the operator may conserve the upper extremity of the ulna or at least the olecranon with the insertion of the triceps. Then the tendon of the biceps may be fixed to the anterior portion of the remaining bone, and one may in this way obtain a mobilization of the olecranon forward and backward. Similar cineplastic amputations have been devised for the wrist. In this case, the carpus is left in place and is mobilized in flexion by the tendon of the flexor carpi-ulnaris and the flexors; in extension, by the extensors of the fingers.

Cineplasties by Individualization of Bones: In this group, the author classifies such operations which individualize certain bones which normally are united in function, *viz.*, the two bones of the forearm and the metacarpals. It is possible on the forearm to effect a pincher-action between radius and ulna. This is being done in Krukenberg's operation, first presented by Krukenberg at the third congress of war surgery in Brussels in February, 1918. The operation of Krukenberg consists in separation of radius and ulna up to a

certain level and in epidermisation of the two prongs. This operation is very disfiguring and hideous and for this reason often opposed by the patients.

4. The Phalangization: The method is a method of Italian authors (Putti), as is the forcepization of the metacarpals. By a longitudinal section of the interior metacarpal tissue, it is possible to give a certain individuality to the metacarpals, especially to the first and fifth, which are more movable.—*A. Steindler, Iowa City, Ia.*

PERMANENT RESULTS OF THE OPERATION OF THE SEMILUNAR CARTILAGES OF THE KNEE. Baumann. *Archiv Orth. und Unfallchir.*, Vol. 19, No. 2; July, 1921.

Among 94 patients who were re-examined following operation on the semilunar cartilages of the knee, four were excluded on account of complications with tabes, polioarthritis, and arthritis deformans. Among the remaining 90 patients, the results were as follows:

Absolutely free from disturbance or complaint	32
Functional cure	15
Complete functional efficiency as regards patient's occupation	37
Slightly diminished functional efficiency	4
Considerably diminished functional efficiency	2

These statistics show that 52% of the patients had splendid results, and only 6.6% were unfavorable. The resumption of work may be undertaken as early as four or five weeks after the operation, and, almost without exception, in eight or ten weeks. In more than one-half of the operated cases, a complete return of functional ability may be expected as early as two months after the operation. On the basis of his experience, the author maintains that the functional disability caused by dislocation of the semi-lunar cartilage may be remedied safely by surgical interference, and that absolute indication for removal exists in those cases in which conservative treatment with fixation, heat or massage, carried on for several weeks, does not definitely cure the condition.—*A. Steindler, Iowa City, Ia.*

THE BIOLOGY OF BONE DEVELOPMENT IN ITS RELATION TO BONE TRANSPLANTATION. Philip William Nathan, M.D. *New York Medical Journal*, October 19, 1921.

This paper summarizes our knowledge regarding bone development and bone regeneration. It especially emphasizes the fact that ossification takes place only in the presence of the cells known as osteoblasts, which are neither changed cartilage cells nor changed connective tissue cells but cells of independent origin, probably brought to the area to be ossified by the blood vessels. These cells occur in only two localities, *viz.*, the cambium layer of the periosteum and of the endosteum.

There is, at present, a difference of opinion regarding bone development, particularly as related to bone transplantation. The point in debate concerns the viability of the periosteum and its ability to produce new bone when transplanted.

If the transplanted periosteum carries with it the cambium layer, with its osteoblasts, it will produce bone. If it consists only of the connective tissue sheath without osteoblasts, it will not.

Even under most favorable circumstances, bone transplanted with osteoblasts is invariably absorbed, the bone serving merely as a scaffolding for the building of new bone by the osteoblasts. This is what happens when grafts without periosteum or endosteum, or when grafts of boiled bone or ivory are implanted, osteoblasts from adjacent healthy bone invading the graft and building new bone on it as a scaffolding.—*C. L. Lowman, Los Angeles.*

BONE DISEASES

SCLEROSING NONSUPPURATIVE OSTEOMYELITIS AS DESCRIBED BY GARRÉ. S. Fosdick Jones. *Journal A. M. A.*, September 24, 1921.

The rarity of this type of sclerosing nonsuppurative osteomyelitis as described by Garré, prompts the author to present a case which had come recently under his observation. These sclerosing types of osteomyelitis are characterized by enlargement and thickening of bone without the occurrence of suppuration or fistulous formations. Garré first described this condition in 1891.

In the large majority of cases, the onset is acute, accompanied by high fever, swelling, pain at the site of bone lesion, and considerable infiltration of the soft parts. The skin is not reddened, and there is no formation of pus. Among 555 cases of osteomyelitis observed at the Tübingen clinic, only 20 cases were of the sclerosing nonsuppurative type. Lange in 1904 referred to these cases, which are characterized by an absence of suppuration, as periostitis albuminosa, reporting a case in a lad of 12 years. The differential diagnosis between sclerosing osteomyelitis and bone sarcoma is frequently very difficult. There is also the possibility of confusing this lesion with syphylitic lesions.

The syphilitic osteitis and periostitic infections of bones results in fusiform enlargement of the shaft and lead to a diffused hyperostosis, closely resembling the chronic stages of nonsuppurative osteomyelitis. Night pain is common to both conditions. The absence of other syphilitic manifestations, the gradual subsidence of the pain, and the finding of a negative blood and spinal fluid Wassermann reaction, should establish the diagnosis. In bone sarcoma, the problem is even more difficult as there is frequently a previous history of trauma. Again the absence of glandular enlargement, of cachexia, and repeated loss of weight are important points in differentiating this type from malignant bone disease. The case of the author concerned a boy nine years old who, in June, 1918, had sustained a slight injury to the right leg and who was free from symptoms from June to December, 1918, with exception of a slight swelling over the anterior surface of the leg. In December, he had another trauma, and following this, there was a rise of temperature to 100.8° and persisting pain over the site of the injury. The x-ray pictures showed distinct enlargement of the right tibia. He was operated upon, and the periosteum was found normal in appearance. It was not adherent. No pus was found in the medullary canal. The microscopic examination showed no evidence of sarcoma, and

cultures taken from the medullary canal showed no growth at the end of 48 hours. There was no evidence of any tumor formation.

Conclusions: Sclerosing nonsuppurative osteomyelitis as described by Garré is a distinct entity. The differentiation between sarcoma of bone, bone syphilis, and osteitis fibrosa is frequently very difficult. In some instances amputations for supposedly malignant diseases of the extremities have been performed in cases which clearly presented the nonsuppurative sclerosing form of osteomyelitis. In doubtful cases of bone disease an exploratory excision should be made.

In the discussion of this paper, Sir Robert Jones, of Liverpool, remarked that he had not seen the original article by Garré, and that since 1900 he had observed those fusiform swellings, which at first sight may be taken as syphilitic. The difference, he thinks, is very obvious. It is very marked in the periosteum. The little depressions and corrugations in the bones and the firm attachment of the periosteum to the tibia are characteristic of syphilis, while the periosteum strips off very easily from the smooth bone surface in Garré affection. Sir Robert Jones has adopted a similar treatment to that of the author, namely, a deep incision, even gutting of the bone. The condition once healed may recur and Sir Robert had a case in which the swelling recurred 18 months after the first operation, necessitating a second operation. In some cases the pain is very severe, and he has been accustomed in various types of bone thickening, especially also in Paget's disease, to relieve discomfort by a linear osteotomy into the medulla.—*A. Steindler, Iowa City, Ia.*

Disease of the Tarsal Scaphoid in Young Children. Abrahamsen. *Revue d'Orthopédie*, July, 1921, p. 313.

This paper is a brief report of a case of Köhler's disease which showed improvement under thyroid treatment. A boy of seven, born of healthy parents and with no previous history of illness or injury, began to limp and to complain of getting tired easily, although he walked without support of any kind. Symptoms were in the right foot. This foot was normal in appearance. There was no pain on pressure and no limitation of motion. The calf muscle showed an atrophy of 2 cm. The roentgenogram showed that the scaphoid was almost absent.

Powdered thyroid gland was given 15 centigrams a day. At the end of three months the bony part of the scaphoid with 7 mm. thick, and in two months more it was 9 mm. The disease is regarded as an anomaly in development.—*William Arthur Clark, Pasadena.*

Köhler's Disease. George I. Bauman, M.D. *Journal A. M. A.*, October 1, 1921.

The author gives a brief résumé of Köhler's description of the disease in 1908. Dr. Bauman concludes that "the most one can say is that it is probably an osteitis due to trauma or absorption from some focus of infection, and that this osteitis interferes with the normal development" of the scaphoid bone. He reports two cases, and the paper is illustrated with two excellent half-tones of skiagrams. The treatment consists of plaster splints and crutches for two or three months.—*H. A. Pingree, Portland, Me.*

Roentgen-ray Therapy in Chronic Diseases of the Bones, Joints, and Tendons. Herman B. Philips, M.D., and Harry Finklestein, M.D. *New York Medical Journal*, October 19, 1921.

For the past two years the authors have been developing a technique for treatment of chronic bone and joint diseases by x-ray. This has been attempted before but has often failed, probably because of too intensive and destructive application. The authors' plan of treatment consisted of rounds of exposure, repeated monthly. The conditions reported as treated include tuberculous arthritis and osteomyelitis and ganglia chronic tenosynovitis, in both of which conditions the results were prompt and very satisfactory; chronic pyogenic osteomyelitis, in which separation of sequestra and closure of sinuses seemed to be materially hastened, and chronic arthritis, in which no actual changes in the joint were produced by the x-ray, but relief from pain was prompt. In summary, the authors feel that "Roentgenotherapy is available as probably the greatest but least used therapeutic agent in the orthopaedist's armamentarium."—*C. L. Lowman, M.D., Los Angeles.*

SCOLIOSIS

Treatment of the Sharp Costal Gibbosity in Scoliosis by Open Operation as Supplement to Orthopaedic Treatment. Gaudier and Swynghedauw. *Revue d'Orthopédic*, July, 1921, p. 265.

The orthopaedic treatment of scoliosis has been very satisfactory in the majority of cases of the past few years. However, there are some inveterate irreducible forms accompanied by a sharp angulation of the ribs upon which the most careful orthopaedic procedures produce no notable effect. In such cases this angulation of the ribs is a distinct obstruction to correction of the vertebral curvature, and, although it is secondary to the curvature, it constitutes the most prominent visible deformity, and is more of a hindrance to respiration than the curve itself. Osteotomy and resection of parts of ribs would seem to render the curvature more amenable to correction. This was first done by Volkmann, who resected the entire twelfth rib and the salient part of the tenth and eleventh in a girl of 15, after which the scoliosis was much improved by orthopaedic measures which produced no result before the resections. Later he obtained a very interesting result by resection of the lower seven ribs in another case. Hoffa also obtained results which exceeded his hopes in a child of 10 by resection of the third to the eighth ribs from near the vertebra to the axillary line. Casse, a Belgian surgeon, has also had encouraging success with the same method.

The authors report two cases:

1. Girl of 14½ with no sign of rickets and a negative previous history. Right dorsal scoliosis with a marked angulation of the ribs displacing the scapula outward and causing an unsightly hump, readily noticeable under the clothing.

The fourth to tenth ribs were most involved. Neither suspension in extension nor treatment by acute flexion had any effect on the curve. In May, 1920, subperiosteal resection of the fifth to ninth ribs was done, 8 to 10 cm. of each rib being removed at the most prominent part of the curve. The angulation is now scarcely apparent and the scapula lies in its normal position. The gaps in the ribs are filling in from periosteum and some of the ribs have rejoined.

2. Patient, age 15, right dorsal curve with angulation of last six ribs, summit at the ninth. It did not yield to extension or flexion treatment. Resection of sixth to eleventh inclusive in August, 1920, through a U incision of which the horizontal lines were about 20 cm. in length. Length of resected portions about 12 cm. Patient able to be up the eighth day and to breathe without difficulty. In September it was possible partly to correct the spinal curve and a plaster jacket was applied to produce corrective pressure.

The preferred incision for the operation is a U with limbs horizontal. The resection is done according to the classical technique. The angulation renders the dissection of the pleura more difficult than usual, but an accidental puncture is easily covered by a flap of neighboring muscle. It is wise to insert a filiform drain for 48 hours. As soon as the wounds permit, a plaster corset is applied with spine in slight flexion. Through windows in the cast, progressive pressure is made to correct the curvature.

The authors have also made some investigations on anatomic specimens and have found that by multiple rib resections a deformed thorax can be reformed practically to normal.—*William Arthur Clark, Pasadena.*

Result of Extensive Rib Resection on the Concave Side in Severe Scoliosis. Fritz Lange. *Zeit. orth Chir.*, Vol. 41, No. 3, May, 1921.

Although only one case is quoted by the author, general conclusions are drawn from it. The author believes that in some of the severest types of scoliosis one may obtain considerable improvement by increasing secondary curves above and below in the course of a preoperative treatment.

The experiments made by Sauerbruch with resection of the thorax seem to offer a favorable opportunity for attacking the problem of scoliosis in an operative way. The author refers to the experiences of Hoessly, who has reported two cases of rib resection in scoliosis. He refers also to the question of tenotomy of the concave side muscles, which, in his opinion, is to be condemned unconditionally. The cutting of these muscles, especially of the erector spinae muscles, will prevent the important function of these muscles in opposing the tilt of the whole body toward the side of the convexity.

The author's patient was a 19-year-old boy who had a right dorso-lumbar scoliosis. The operation was performed by Sauerbruch. An incision ten inches in length was made above and parallel with the vertebral border of the shoulder blade, as is used for lung plasty. Resection of 5 cm. of the eighth rib was performed. From the ninth rib down difficulties arose due to the overlying musculature so that incisions of the musculature were frequently necessary. Following the operation, the tilt to the right was possibly a little less. The mobility of the spine was the same as before, but there was a distinct flattening of the dorsal curve. The gymnastic treatment which followed operation improved the posture

but did not produce any further improvement. In order to obtain greater mobility of the spine, a second operation was performed through an incision as for plasty of the upper lobe of the lung. This time there were resected pieces of 4 and 5 cm. in length from the first and seventh rib. After the removal of the seventh rib, the left side of the thorax collapsed, and improvment of the condition was not noticed either in regard to posture or in regard to mobility.

There was, shortly after the operation, an improvement in that the tilt to the right was further corrected. But when the patient presented himself six months after the second operation, it was found that the increase of mobility obtained after the first operation which had persisted for two months of his hospital observation, had been lost entirely.

The author believes that the posture at large has been improved by the operation owing to the fact that the convex side tilt of the entire body was considerably improved. He also believes that a loosening of the rigid section of the dorsal spine was due to the operation. The second rib resection did not bring an increase in mobility of the rigid section of the spine. Taking it all in all, the resection of ribs in cases of rigid scoliosis does not offer any great hope for correcting or improving the deformity. The author warns against an indiscriminate adoption of this operation.—*A. Steindler, Iowa City, Ia.*

Is an Operative Treatment of Scoliosis Possible? H. Hoessly. *Zeit. orth Chir.*, Vol. 41, No. 3, May, 1921.

Two cases are reported in which a thoracoplasty of the concave side was performed.

(1) Girl, 16 years, with right convex dorsal scoliosis and low rotation. A thoracoplasty was performed under local anaesthesia, five ribs being resected to the extent of 1 to 1½ cm. each.

(2) Boy of 13 years, with a left dorsal scoliosis of the upper and the right dorsal of the mid-dorsal region. A thoracoplasty was performed, with section of three ribs (three to nine), and the removal of small pieces from each.

In both cases there was a very slight stretching of the spine noticeable following operation. The author says that he has no definite idea how many ribs and to what extent they are to be resected in the different cases, since such knowledge would have to come from a larger experience. He also mentions the clinical experiences following the Albee and de Quervain transplantation of bone into the spinous processes, citing one case. This case showed that the correction obtained before the operation had persisted following transplantation, and he concludes that the transplantation of bone into the spine is very apt to secure the improved position obtained by preoperative methods. It is, according to the author, the method of choice.

He further opens the question of direct attack upon the spine through the abdominal cavity, but aside from general considerations, nothing definite is said. Only for the lumbosacral regions the author believes that such a method will become practicable.—*A. Steindler, Iowa City, Ia.*

CONGENITAL DEFORMITIES

THREE CASES OF CORACO-CLAVICULAR ARTICULATION OBSERVED IN LIVING. F. Frasseto. *Chir. Org. Movim.*, Vol. 5, No. 1, Feb., 1921.

Observations of three cases from the radiological laboratory of Dr. F. H. Baetjer of the Johns Hopkins Hospital in Baltimore. The x-ray picture showed an anomalous osseous process arising from the inferior surface of the clavicle. It had a trapezoid shape with its base directed toward the clavicle and its apex toward the coracoid process. This bony prominence carries an articular facet which articulates with the tip of the coracoid process. The form of this anomalous process corresponded in site, size and form to the two coraco-clavicular ligaments (conoid and trapezoid), as well as to the less known ligament of the superior surface of the clavicle named the bicorne ligament of Caldoni. This distribution demonstrates the existence of a true articulation due to ossification of these ligaments. From the standpoint of comparative anatomy, it is mentioned that such an articulation, analogous to the coraco-clavicular articulation of man, has been found in the gorilla and hylobates. According to recent investigation, especially in studies of English and American authors, this so-called Caldoni's ligament or coraco-costal ligament represents part of a skeletal element. Starting from the marsupialia, the coracoid enters in a process of regression until it has reached the rudimentary form found in man. This bicorne ligament of Caldoni, therefore, represents the caudal end of the disappearing coracoid process. The coraco-clavicular ligaments represent the lateral portion of the pro-coracoid or the cranial coracoid.

In regard to the clinical significance of this anomaly, it is mentioned that in one of the three cases, there was a fracture of the surgical neck of the humerus; according to the author this fracture was considerably enhanced by the presence of the coraco-clavicular articulation. The coraco-clavicular ligaments have for their principal function the fixation of two bones, namely, the scapula and the clavicle, but because these ligaments are long and elastic, they admit of some amount of displacement between the two bones. In case of ossification of these ligaments or in case of articulation between the two bones, the union between scapula and clavicle is much more solid. It can easily be seen that in these instances, the counter-coup, which transmitted from the head of the humerus to the glenoid fossa could not be lessened by the elasticity of the ligaments and the lack of give between the two bones, causes or contributes to the fracture of the head.

The author also found that in two of the three cases the anomaly was associated with tuberculosis. From this it may be inferred that one deals, possibly, with the subjects of phthisical habitus. The higher frequency of the articulation in women is also noted by the author, although no explanation is ventured for this fact.—*A. Steindler, Iowa City, Ia.*

PROGRESSIVE FOOT DEFORMITIES IN SPINA BIFIDA OCCULTA. L. Roeren. *Archiv. Orth. u. Unfall. Chir.*, Vol. 19, No. 1, May, 1921.

In this study, the author refers to the investigations of Duncker and Bibergeil, both of whom have tried to establish definitely the connection of the foot de-

formities with clefts of the spinal column. Bibergeil modifies his statements by saying that, in spite of the numerous relations existing between spina bifida occulta and pes cavus, an etiological connection between these two conditions cannot be assumed under all circumstances. Duncker, however, goes farther and concludes from the defects of the spine that there exist primary developmental errors in the spinal cord itself. But the often late beginning and the slow progression of the deformity, together with the frequent unilaterality of the condition, call for further explanation. Duncker and others describe strands of scar tissue starting from the skin and reaching through the vertebral cleft into the vertebral canal. This fibrous strand is supposed to impede the normal ascent of the medulla in the vertebral canal. Recklinghausen described a case of a man 25 years old with hypertrichosis in the sacral region and left club-foot, in whom the conus medullaris was at the level of the second sacral vertebra and not, as normally, at the level of the second lumbar vertebra. Such cases might explain, upon a mechanical basis, the failure of the medulla to ascend. A second type of pathological changes are tumors lying between medulla and the bone and exerting pressure upon the former. These tumors are mostly or purely lipomatous; but even these findings are not likely to explain to satisfaction the syndrome of spina bifida occulta with progressive foot deformities, as there are no instances in which a complete paralysis developed, such as should be expected with the growth of a tumor. Malformation in the medulla is not progressive but stationary and consists, according to some observers, in localized defects and, in more advanced degrees, the anterior tracts and anterior horns themselves as well as the posterior roots, may be involved. In contrast with poliomyelitic paralysis, the paralysis is here more disseminated affecting only single muscles or single muscle bundles or fibers so that it is often very difficult to establish the presence of paralysis clinically. This abnormal condition of the medulla is, in the opinion of the author, to be considered the pathological basis in the mild and moderate cases of spina bifida occulta with progressive foot deformities.

It seems that certain epochs of life are especially prone to develop these deformities. Aside from the condition at birth, there are certain periods when the deformity makes decided progress. One of these is the third year and another the seventh year of life. Under the influence of disturbed muscle equilibrium, the formerly normal-shaped foot may begin to turn at this age. The author then proceeds with a rather lengthy explanation of the muscle mechanics leading to the peculiar deformities of spina bifida occulta. He is especially desirous to show that the transformation of the foot from the normal into the equinus position with increase of the arch is the result of the play of the flexor muscles under conditions of disturbed equilibrium. The consideration of the musculomechanical conditions will readily explain why the three types, namely, the equinus, varus, and cavus, are so predominant. The topography of the anterior horn columns from which the motor nerve fibers take their origin teaches that the columns for those muscles, whose function is the plantar flexion of the foot and the increase of its arch, are situated more caudally than are the cell columns which supply the extensors of the toes and the tibialis anticus. By elimination or weakening of their antagonists, these muscles, namely, the flexors and heighteners of the foot, go into contracture and give rise to the progressive foot deformity in spina bifida occulta. It is pointed out, furthermore, that in any condi-

tion of irritation of all muscles such as would be the case in medullary lesion higher up (upper neurone), such positions of contractures might easily occur, especially if enhanced by slight external causes such as position or pressure of the covers, etc. From these considerations, it will become clear why the vast majority of the foot deformities observed in spina bifida occulta present a combination or variation of the types of equinus, varus, or cavus.

In conclusion, the author assumes that spina bifida occulta is a malformation having its seat in the lowest part of the spine. It becomes established in the first weeks of intrauterine life when the closure of the medullary trough should occur, but is then disturbed for some reason. The conus medullaris often is adherent to the posterior surface of the canal by adhesions, and this is a factor which might bring about progressive damage or injury to the medulla.

Since, due to the distribution of musculature and the configuration of the joints, conditions are very propitious for the formation of an equino-cavus, and since the functional disturbance in most of the cases is of spastic character, it is easily explained that in the majority of the cases the above-mentioned deformities occur, enhanced by conditions of contracture on the part of the hypertonic muscles, and relaxation on the part of their antagonists. The treatment has to consider the condition of the medulla in the first place; that is, the removal of adhesions or tumor in the vertebral canal. The local condition of foot deformity demands operative interferences upon the structures and deformed bones.—*A. Steindler, Iowa City, Ia.*

CONTRIBUTION TO THE PATHOLOGY AND THERAPY OF THE CONGENITAL PES ADDUCTUS. W. Jareschy. *Zeit. orth. Chir.*, Vol. 41, No. 4, June, 1921.

Cases of this type have first been described by Kramer in 1904. They represent a typical congenital deformity of the foot. Helbing found among 5,000 orthopædic cases five times metatarsus varus congenitus. The characteristic point of this deformity is the deviation of the second to fifth metatarsals which form an arc curved outward, the metatarsals being adducted and, to a slight degree, plantar flexed. There is also a typical broadening of the region of the metatarso-phalangeal joints caused by the fan-shaped deviations of the metatarsi. The first metatarsal bone is not curved but simply adducted.

The posterior part of the foot, in cases which already have walked, is in position of pronation so that the foot seen from behind looks like a pronated foot. In the cases of Froelich, there was an unusual development of the big toe and extraordinary mobility. Cramer distinguishes between the pes adductus and the metatarsus varus, the latter being characterized by the general curving of the foot already mentioned. In the metatarsus adductus, the curving of the metatarsals is missing, and there is simply a medial deviation of the metatarsi.

The mobility of the foot in both instances is limited in regard to pronation and abduction. There is also a flattening of the arch and secondary deformities of the toes to be considered as complicating symptoms.

A case of this type is described by the author. In this case, there was also a spina bifida occulta which, in view of the progressive character of the deformity, leads one to assume a causal connection between the deformity of the spine and the deformity of the foot, similar to what has been described in regard to spina bifida and hollow clawfoot by Bibergeil and Duncker. It is quite possible that

the adduction of the forefoot will be brought about by pure muscle action such as might be at work in conditions of muscular unbalance due to spina bifida occulta. In this case, however, there was such an extensive displacement of the scaphoid toward the lateral side of the foot that the author doubts that it could have been brought about by muscle action alone.

In this particular point, the case of the author is rather unique, as the displacement of the scaphoid has not yet been described (with the possible exception of Terterianz' case).

Manual redressment is the generally employed measure for correction of the deformity. Redressment should be carried out at an early age.

A description of the technique has been furnished by Froelich. He adds to the redressment in cases with pronounced abduction of the big toe the osteotomy of the first metatarsal and oblique section of the extensor hallucis. Other methods described have been the reefing of the peroneal tendons and the transplantation of the tibialis anticus to the lower median surface of the scaphoid and the tendon of the abductor hallucis from the median to the lateral sesamoid bone. In the case described by the author, another operative procedure was adopted which is described as follows:

A piece of bone taken from the tibia was implanted into the fissure between the head of the astragalus and the inner cuneiform bone. The operation was successful and the correction complete. Plaster of Paris dressings were applied and worn for about three months and were then followed by a celluloid arch support. One year after the operation, the mobility of the foot had increased and the patient was able to be on her feet all day long.—*A. Steindler, Iowa City, Ia.*

METABOLIC DISEASES

Etiological Treatment of the Rachitic Deformities of the Thorax. R. Boeckh. *Archiv Orth. und Unfall. Chir.*, Vol. 19, No. 2, July, 1921.

Quisling found among 1000 rachitic children, rickets of the skull 316 times, rickets of the spine 47 times, rickets of the extremities 592 times, dentition rickets 233, and rickets of the thorax 694. In the rachitic thorax there is a decided difference in the sagittal diameter in the upper half as compared with the lower half. While the sagittal diameter in the upper part of the thorax is unusually large, it becomes very much shorter in the lower. There is also a prominence of the sterno-clavicular portion of the upper aperture, a depression of the parasternal region and a spreading of the lateral portion of the lower aperture. In the normal child, in each expiration, the abdomen protrudes slowly while the thorax shows no or little movement. In the rachitic child, the thoracic movements are vastly different. The dome of the diaphragm moves more in lateral direction than up and down and the lateral portion of the thorax shows a very distinct inspiratory depression. Both the pressure of the arms touching the thorax laterally and the action of the diaphragm are made responsible for the deformities of the thorax, which, in short, consists in the protrusion of the anterior thorax, the chicken breast, the retraction of the parasternal portions of the thorax, the transverse furrow around the thorax, and finally,

the spreading of the lower aperture and the protrusion of the abdomen. It is a matter of experience that a large percentage of the rachitics have adenoids, and the author believes that these contribute in a large measure to the thoracic deformities. The child with adenoids has to call upon his auxiliary respiratory muscles, of which the scaleni and the sternocleido mastoid are especially important. The action of these muscles pulls the upper aperture of the thorax upward.

In accordance with these views, the author endeavors to direct the therapy towards the causative agents of this deformity, namely, the removal of adenoids and other obstacles in the upper air passages, such as nasal polyps and hypertrophic tonsils. In addition to this, he also uses an abdominal binder which reduces the protrusion of the abdomen and supports the weakened abdominal muscles. It is the author's opinion that the physical therapy of rickets of the thorax should begin as soon as the diagnosis is made and as soon as the general treatment of rickets is being instituted.—*A. Steindler, Iowa City, Ia.*

Schlatter's Disease and Frequent Symptoms of Late Rickets. Bernard Hinrichs. *Zeit. orth. Chir.*, Vol. 41, No. 3, May, 1921.

The ossification of the tibial apophysis occurs mostly between the 12th and 15th year. Between the first appearance of the bone nucleus and the completion of ossification, not more than three to four months are required. Only a thin cartilage zone remains between the tuberosity and the tibial diaphysis to about the 18th year. The apophysis sends a process over the anterior surface of the head of the tibia while from below an independent bone nucleus grows against it until, at the level of the epiphyseal disk, the fusion occurs. According to Bergmann, there exists even in the normal, an extraordinary irregularity of the ossification. Schlatter concludes that there are extrinsic factors which contribute to the condition, for instance, that the ossifying apophysis is easily exposed to direct or indirect traumatism, especially at the point of junction between the upper or the lower apophysis. However, in the majority of the cases reported, there is no mention of a trauma.

Thompson reports a periostitis at the point of insertion of the ligamentum patellae caused by pull of the quadriceps. Kienbock, upon the basis of his radiological findings, concludes, at least for part of the cases, that there exists an active destruction of the bone of the tuberosity together with an inflammatory reactive swelling; in other words, an osteochondritis. Ebbinghaus considers the condition as an epiphysitis desiccans traumatica. So it appears that the views on the etiology of this deformity are by no means in harmony. It was Joachimsthal who pointed out that, aside from inflammatory changes, pathological changes of ossification analogous to those seen in late rickets are to be found. Similarly, Fromme, in a large clinical material, found that a number of cases afflicted with late rickets showed the signs of Schlatter's disease,—deducing from it that Schlatter's disease occurs in the majority of cases in patients afflicted with late rickets. The author has subjected the reports in the literature to a critical study. He points out that if severe changes are seen on the long pipe bones in regard to ossification and growth, in an individual afflicted with late rickets, such would also have to be expected to occur in the tibial apophysis where a comparatively thin bone plate rests upon a thick layer of cartilage. The pull

of the quadriceps tendon may easily lift the process off its cartilage base and cause a kinking of the base of the apophysis. Severe signs of late rickets existed in all cases which were studied. The author concludes that Schlatter's disease, in many cases at least, is merely a symptom of late rickets.

It occurs in a portion of the tibia which by virtue of its anatomical configuration and its exposed situation is especially open to direct or indirect traumatism. But in all cases in which the changes occur without traumatic influence, one should think of late rickets: (It is to be regretted that the author does not use the term Osgood-Schlatter's disease).—*A. Steindler, Iowa City, Ia.*

THE ORIGIN OF THE GENU-VALGUM FROM THE PES VALGUS. Elizabeth E. Schmidt. *Zeit. orth. Ch.*, Vol. 41, Nos. 1, 2; April, 1921.

Hueter's explanation of the genu-valgum was based upon difference of growth in the outer and inner halves of the epiphysis. According to his view, there is increased pressure on the outside of the joint while the pressure on the inside is diminished. In consequence, there is atrophy of the outer and hypertrophy of the inner condyle of the femur (the assumption of the relation between atrophy and pressure is, for the cartilaginous tissue, open to grave doubt). Mikulicz pointed out that deformity is not situated in the epiphysis, but rather in the diaphysis. He considers the abnormal slenderness of the femur and constitutional changes akin to rickets as the cause of the deformity. Julius Wolff sees the cause of the transformation in the change of the static condition under which the extremity functionates so that the genu-valgum represents nothing else but the functional readaptation of bone and soft parts of the extremity to the repeated outward rotation of the leg.

Schanz pointed out that the abnormal position, such as over-extension, outward rotation and abduction in the knee, is already an effect of genu-valgum. All these theories have been criticized by Lange, who remarks that it is by no means clear why an extraordinary strain of the knee joint causes genu-valgum. Thigh and leg formed under normal conditions have already an angle which opens laterally. It, therefore, could be expected that any abnormal weight-bearing upon the leg will increase this angle and cause knock-knee deformity. Of interest is the observation of Francke, who established by investigations on 1,099 people, that usually the bow-legged and, more rarely, the normal shaped legs of the children become knock-kneed when walking is begun.

In order to establish the static conditions which lead to knock-knee deformity, the author has made studies upon a model in which the effect of pes valgus upon the knee-joint was investigated.

She finds that in all cases the genu-valgum presupposes a pes valgus, that it only appears in combination with knock-ankle. From the third year on, the most common deformity is the knock-knee.

Fifty-five per cent. of the children suffering from pes valgus also showed more or less knock-knee deformity; consequently, the treatment should be directed toward the correction of the pes valgus. This is accomplished by insoles, wedges, and especially by active exercises which develop the varus position of the foot. To these are added passive manipulations by means of straps which hold the legs in middle rotation and the foot in varus position. The author believes

that the treatment is so effective that if continued too long, the opposite deformity may develop. (!)

She concludes that the genu-valgum represents an adaptation of the extremity to the shifting of the plumb line outward which is caused by the existing pes valgus. The changes in the joint consist in stretching of the capsular apparatus of the knee-joint, causing a flail joint and leading subsequently to characteristic changes of the bone.

The X-ray shows that the bony changes are situated mostly in the diaphysis of femur and tibia, while the epiphyses are not changed.

In a large number of the cases examined, there was found hypertrophy of the lateral portion of the cortical bone of the tibia, which is considered as an expression of the adaptation of the deformity, conforming to Wolff's Law.

The treatment which is directed toward the correction of the pes valgus results in complete cure of the knock-knee deformity and proves, according to the author, that the knock-knee is secondary to pes valgus.—*A. Steindler, Iowa City, Iowa.*

TRAUMATISMS.

Injuries of the Feet. U. V. Portmann and F. C. Warnshuis. *Jour. A. M. A.*, April 30, 1921, p. 1214.

This is a very instructive paper and merits the attention of any one who is engaged in industrial work. The authors state that of all industrial accidents 20 per cent. are of the feet, and they are usually looked upon as minor injuries, a short convalescence is expected, and we are always disappointed. The following management of foot injuries is advised; immediate rest and elevation, x-ray, early motion if joints are involved, every wound treated as infected, but care is to be exercised in making incisions.—*C. B. Francisco, Kansas City, Mo.*

Dislocation of the Sacro-iliac Joint. Alexander Gibson. *Jour. A. M. A.*, May 28th, 1921, p. 1487.

One case is reported in a boy eight years old who was in an automobile that was struck by a train and he was generally severely injured. Three days later the diagnosis of dislocation of the left sacro-iliac was made, and a week later the x-ray confirmed it and did not show any fractures. Three weeks later at operation the projecting posterior ilium was sawed through, the adjacent sacrum was freshened, the dislocation reduced, the piece of ilium replaced and the child made a perfect recovery.

The statement is made that these conditions are rare.—*C. B. Francisco, Kansas City, Missouri.*

A Case of Bilateral Dislocation of the Hip-Joint. Walter G. Stern. *Jour. A. M. A.*, May 28, 1921, p. 1496.

Stern's case was a woman 22 years old, who was thrown from a speeding automobile and hurled across the pavement, striking the curb feet-foremost. She at first complained so much of pain in her right foot and leg, in which she had a complete peroneal palsy, that her hips were overlooked for seven weeks,

at which time she was placed on the Hibbs table for reduction of the right hip and it was discovered that the left hip was also dislocated. She had, however, never complained of the left leg or hip. No difficulty was encountered in the reduction. This is the fortieth case recorded.—*C. B. Francisco, Kansas City, Mo.*

DISLOCATION OF RADIUS FORWARD AT INFERIOR RADIO-ULNAR JOINT. L. Rogers. *British Med. Jour.*, April 30, 1921.

One case is reported, this being a man 39 years old who received an injury while cranking his car. A fractured carpal bone was suspected but x-ray revealed only a forward dislocation of the radius at its ulnar articulation. Reduction was easy and a good result reported.—*C. B. Francisco, Kansas City.*

OBSERVATIONS BASED ON A STUDY OF INJURY TO THE ELBOW. Isidore Cohn. *Annals of Surgery*, Sept., 1921, p. 357.

A careful study of x-ray plates in the normal elbow shows that if the joint be flexed to a right angle a lateral view shows the capitellum occupying the sigmoid cavity. In early life there seems to be a wide separation between the articular surface of the capitellum and the great sigmoid cavity, but with growth the capitellum comes to occupy the entire cavity. In cases of injury there is a disturbance of this relationship between the capitellum and the greater sigmoid cavity.

A plane passed through the middle of the long axis of the humerus prior to about the eighth year passes behind the posterior border of the capitellum; after this period the plane bisecting the shaft of the humerus has approximately two-thirds of the lower epiphysis anterior to it. A plane at right angles to the base of the capitellum and bisecting it intersects the plane through the middle of the long axis of the shaft at an angle of about 130°. With the forearm extended on the arm and supinated, a plane passed through the long axis of the humerus is intersected by a plane through the middle of the axis of the ulna at an angle of approximately 170°. A careful history and thorough clinical examination plus the use of these planes in the study of the x-rays will aid greatly in establishing the diagnosis in cases of supracondylar fractures and separation of the lower humeral epiphysis. They are also of great value in determining if accurate reduction has been obtained.

In treatment of injuries to the condyle and separation of the epiphysis, the acutely flexed position is used whenever it is possible. Emphasis is placed on position of the forearm with reference to the arm. In fractures of the internal condyle the forearm should be placed in pronation because contraction of the pronator teres tends to pronate the arm and to pull the bony fragment away from the shaft of the humerus. In fractures of the external condyle, the position of greatest stability is hyperflexion and supination.

The after-treatment is important, and as hyperflexion results in contracture of the flexor group of muscles, it is essential to diminish flexion as early as it is safe. Usually extension is begun on the tenth day but should be limited by pain. The position of flexion with the arm across the chest leads to weakness of the external rotators of the arm, and therefore exercise of these muscles should begin early.—*LeRoy C. Abbott, Ann Arbor, Michigan.*

The Retention of Difficult Cases of Hip Dislocation by Intercapsular Injections of Alcohol. H. Graetz. *Zeit. orth. Chir.*, Vol. 41, Nos. 1, 2; April, 1921.

Absolute alcohol was used for injection into the joint cavity. The amount injected was 3 c.cm. Injection was made in redislocated position in order to facilitate the introduction of the needle. Altogether 12 cases were treated in this way. The alcohol injections were used in all redislocations which occurred during the period of fixation and also in all cases in which there appeared a great tendency to redislocation immediately after reposition.

Ideal anatomical and functional cures were obtained in seven cases. A good functional result was obtained in two cases. In two more cases, the head redislocated. Considering the uncertainty which is peculiar to any new method due to the deficiencies of the technique, the author thinks that the results are favorable and that the method should be recommended in all cases in which reduction is difficult. He has not observed any untoward effects of the alcohol injection provided certain measures of precaution were used such as the avoidance of the injection of air.—*A. Steindler, Iowa City, Iowa.*

TUBERCULOSIS.

The Statistics of Bone and Joint Tuberculosis in the Last Five Years. From the Orthopedic Clinic of Dr. Gocht. L. Frosh. *Archiv. Orth. u. Unfall Chir.*, Vol. 19, No. 2, July, 1921.

Among 15,000 patients, 1159 or 7.7% were suffering from bone and joint tuberculosis. Author's figure is lower than the statistics of Biesalski (15%) or Lange (12%). Of the 1159 patients, 538 or 46.4% were males, and 621 or 53.6% females.

Distribution according to age:

	Males	*Females*
1 to 5 years	133 or 24.7%	147 or 23.6%
5 to 10 "	204 or 38.8	157 or 25.6
10 to 15 "	93 or 16.5	126 or 20.2
15 to 20 "	52 or 9.5	83 or 13.2

The predominance of the first two quinquennia is evident in both sexes.

In regard to localization, the distribution among the 1159 cases was as follows:

Spine	501 or 43.2%
Hip	268 or 23.2
Knee	199 or 17.2
Ankle	95 or 8.2
Wrist	50 or 4.3
Elbow	25 or 2.2
Shoulder	12 or 1.0
Sacro-iliac joint	4 or 0.3
Diaphyseal tuberculosis	5 or 0.4

The frequency of the disease of the spine is noteworthy.

I. Tuberculosis of the Spine. Distribution:

Of 501 cases of Pott's Disease, 38 or 7½% involved the cervical spine.

321, or 64.7%, the Dorsal Spine.

117, or 22.9%, the Lumbar Spine; and

25, or 4.9%, several sections of the Spine.

The male sex represented 44.5%; the female, 55.5%, of the cases.

The figures of the author are higher than those of Nedder in regard to the distribution during different periods of life.

The tuberculous spondylitis is preëminently a disease of the first decade with preponderance of the female sex.

II. Tuberculosis of the Hip.

268 cases, of which

125, or 46.6%, were in the right, and

143, or 53.4%, in the left hip.

Distribution as to age:

	Males	*Females*
1 to 5 years	26 or 20.8%	25 or 17.6%
5 to 10 "	53 or 41.7	48 or 34.1
10 to 15 "	26 or 20.8	25 or 17.6
15 to 20 "	13 or 10.4	19 or 13.3
All Ages	128 or 47.8	140 or 52.2

There is no noticeable preponderance of either of the sexes. The majority of the cases belong to the first three, especially the second quinquennia.

III. Tuberculosis of the Knee:

199 cases, of which

133, or 69.9%, were in the right, and

60 cases, or 30.1%, in the left knee.

This is a very remarkable preponderance of the right side which is not paralleled by the conditions in the hip.

Distribution according to age:

	Males	*Females*
1 to 5 years	11 or 12.2%	20 or 18.1%
5 to 10 "	26 or 28.4	36 or 32.7
10 to 15 "	21 or 23.3	16 or 14.5
15 to 20 "	17 or 18.9	12 or 9.8

Summary: 89 males or 44.8%; and females, 110 or 55.2%, showing a not inconsiderable majority in favor of the female sex.

IV. Tuberculosis of the Ankle, 95 cases, with preponderance in the first three quinquennia. In this group, there are 59 males or 62.1%, and only 36 females or 37.9%.

V. Tuberculosis of the Wrist.

Fifteen cases, of which the left wrist, in 30%; the right in 70%.

Distribution according to age also shows predominance of the disease in the first two decades. The female sex again is in prominence; 40% males and 60% females.

VI. In the series of tuberculosis of the shoulder, the total is too small to allow of analysis on a percentage basis.

VII. The social status of the patients. Of the 1159 patients, 12.3% belonged to the class of small government employes, 24.7% to the class of small business men, 24.0% to the craftsmen, and 26.9% to the working classes.

Considering the first three as middle classes, then 61% of the patients belong to the latter class, whereas 39% belong to the working classes.

According to the author, these figures again prove the financial deterioration of the middle classes, which is expressed in their hygienic condition and ultimately results in the greater percentage of these classes in surgical tuberculosis. The bone and joint tuberculosis reached its highest frequency in this series of cases during the years 1918-1919.—*A. Steindler, Iowa City, Iowa.*

THE OPERATIVE TREATMENT OF SURGICAL TUBERCULOSIS. F. Koenig. *Arch. klin. Chir.*, Vol. 116, No. 3, Sept., 1921.

The statistics of this author are based upon a selection from about 100 publications, which comprise altogether 4,000 cases with 2,000 resections.

1. Bier, in his uncompromising conservatism, stands, according to the author, entirely isolated. This surgeon considers that the resection of tuberculous joints is not justified. Amputation might occasionally be indicated where there is concomitant pulmonary tuberculosis or a state of sepsis starting from the joint. Since 1913, Bier has performed only one amputation.

2. Another group are those surgeons who first start conservatively and then proceed operatively if conservative treatment fails.

3. A third group is formed by those surgeons who proceed conservatively with a number of cases, but who in certain definite cases believe in primary operations. Garré and others are numbered in this group.

The author considers the questions of how many permanent cures are obtained by successful resection and what is the function of the limb. The study of the statistical table involving 2,000 resections performed by twenty authors shows that in over 68% of the cases a permanent cure was obtained, all joints considered. As far as the function of the cured joints is concerned, the author considers the flail joint as the poorest result. This was seen three times in 148 cases of elbow resection, several times in over 700 cases of heel-knee resections, and twice in the ankle joint. It was noticed once in hip joint resection.

Shortening is a much dreaded complication, especially in children, after resection of the knee. Garré's report on 114 resections in children showed an average shortening of 2.8 cm. As regards the wrist, opinions are divided. Kocher reports 75% of good results.

The functional results do not only depend upon the operative technique, but also upon a long-continued and carefully carried out mechanical after-treatment. Summing up his conclusions, the author states that reliable statistics on the permanent results of the purely conservative treatment in severe joint and bone tuberculosis do not exist on a larger scale. On the other hand, we know from the study of the investigations mentioned that truly permanent cures may be obtained by resection in a remarkably high percentage of the severest cases. In view of these facts, the author feels inclined to formulate the indications for operation in bone and joint tuberculosis as follows:

1. Find the tuberculous foci, especially in the neighborhood of the joints. In case of perforation into the joint, resection is justified.

2. One should also operate in cases of severe secondary infection.

3. In cases of synovial tuberculosis which progress in spite of conservative treatment, and penetrate into the neighborhood, one should not wait until nothing else is left for the amputation, but the decision for operation should be made much sooner.

4. In adults, the decision to resect should generally be made much quicker than in children.

Nevertheless, in many cases, the conservative method is exclusively indicated, and even in resected cases, the conservative means must be employed before and after, since the operation accomplishes not the removal of the tuberculous focus, but rather a localizing of the tuberculous disease. All in all, he believes that at the present time resection in the treatment of bone and joint tuberculosis is a necessary factor in a large number of cases.—*A. Steindler, Iowa City, Iowa.*

THE CONSERVATIVE TREATMENT OF THE SO-CALLED SURGICAL TUBERCULOSIS. A. Bier. *Arch. klin. Chir.*, Vol. 116, No. 1, July, 1921.

The author assumes an almost unique attitude in regard to the treatment of surgical tuberculosis. In the first place, he turns against such operative indications as are recognized even by followers of the conservative trend of treatment.

He does not admit the indication for operation in cases of extracapsular foci in the neighborhood of a joint, because he thinks that these foci heal under conservative treatment with considerable certainty.

2. He does not recognize larger sequestra as indications for operation. Here he thinks the operation superfluous, because under conservative treatment sequestra become absorbed; occasionally they even regenerate and take part in the formation of new bone. The absorption of sequestra takes place not only in closed but also in open forms of tuberculosis with mixed infection.

3. He does not recognize subluxation of the joint, especially of the knee-joint, as indication for resection because, as he says, such subluxation can easily be remedied by simple conservative measures.

4. He does not recognize the operation in cases of spina ventosa, considering that these manifestations do not represent the only focus and therefore with their removal no complete cure is obtained.

5. He does not consider deep cold abscesses as operative indications, as they disappear spontaneously. He only attacks superficial abscesses by puncture.

He condemns the costo-transversectomy on the grounds that the abscesses of the thorax disappear under conservative treatment.

He never performs Albee's operation, which he considers useless.

6. Advanced age is, according to Bier, no contraindication to conservative treatment. He admits, however, that in rare cases it might be indicated in very old and decrepit patients to amputate a leg in sufferers from tuberculosis of the foot or knee.

Bier has religiously refrained from operation in surgical tuberculosis. He has operated (amputated) only once in seven years, in one case. This case was amputated in the leg because one patient insisted upon it. Half a dozen further operations were carried out in the clinic because of the diagnosis being undecided between sarcoma and tuberculosis or because the patients refused conservative

treatment. The author then proceeds to a description of his method of conservative treatment.

1. Heliotherapy as developed by Bernhard and Rollier. Rollier's contention that the pigment produced by the sun transforms the short-wave ultra-violet into long-wave rays which penetrate deeply into the body, is, for reason of physics, untenable. As a matter of fact, there is no proof that the sun's rays have a specific curative influence upon tuberculosis foci. It is to the pigment to which such an action is ascribed generally. Pigmentation is proportionate, according to Bernhard and Rollier, to the individual resistance, and proportionate to the latter, is the curative action of the sun. For this reason, it is maintained that dark-complexioned people respond better than blondes. However, all these theories are more or less problematical and exact scientific proof is still lacking.

Artificial light is used by Bier in substitution for sunlight. He does not recognize specific and favorable action of the violet and ultra-violet rays, but considers all colors of the spectrum effective.

2. The second conservative method used by the author in the treatment of tuberculosis is a passive hyperaemia. As early as 1913, the author was in position to present a number of cases of a very severe joint tuberculosis which were healed by application of passive hyperaemia and, internally, of iodides.

3. The third means which is used in conjunction with the two first mentioned are the iodides, given daily in doses of about 50 grains, as potassium iodide. Iodine is an old remedy for tuberculosis, especially does it act very favorably in conjunction with passive hyperaemia, inasmuch as it avoids or obviates the disagreeable effects of the hyperaemia, consisting in the formation of cold abscesses and the proliferation of granulation tissue. The author has used tuberculin in his institute at Hohenlychen only in the after-treatment and for the prevention of recurrences, but has abandoned it now entirely. He has nothing to say about Friedmann's serum and does not consider it in any way effective.

Bier states emphatically that he has abandoned all plaster of Paris and other immobilizing bandages or apparatus, having entertained a violent opposition to these measures for many years. He says that joint tuberculosis demands avoidance of weight-bearing, but not immobilization. The immobilizing casts are not only superfluous, he says, but also harmful, because they lead to stiffening of the joints. He eliminates weight-bearing simply by bed rest. Contractures and faulty positions are remedied by traction, which acts with absolute certainty and perfection, so that the so-called orthopædic operations are only rarely indicated,—except in such cases as reach his clinic already in a state of ankylosis.

Active motion is carried out in all diseased joints as soon as the pain subsides. He considers it a rule that such motion should never cause pain. In the same way as weight-bearing, so also pain acts destructively upon bone and joints, and provokes ankylosis because it causes muscle spasm and contractures, which press the diseased joint bodies against each other. Nothing, he says, is as destructive as harmful pressure. If you relieve the pain, you stop the destructive pressure, the contractures disappear, and careful movements may be carried out with impunity. (!)

He then proceeds to state that with the treatment outlined above, he is able to remove what he calls ankylosing pain in a period of one to two weeks. Then he allows motion, and he never encounters ankylosis any more in cases which show even a small remainder of mobility. So the three remedies which this

author considers as effective and legitimate are: the sun cure, and, incidentally, artificial light; passive hyperaemia; and, lastly, the internal use of iodides. By far the most potent of these factors is the sun cure, the efficiency of which is not approached by any of the others.

According to Bier the sun cure is not necessarily limited to high altitudes or to dry climate, but it can be carried out under less selected climatic conditions. (Inasmuch as this point has already been noted by Rollier himself, it is not necessary to dwell upon it.)

In his institute, the author has treated in the last seven years, 1,389 cases of tuberculosis. His statistics show that although the patients were recruited from the poorest classes, over 70 per cent. were cured and 20 per cent. improved. The author concedes, however, that without doubt there are a number of cases which show recurrences although discharged as cured; just as, on the other hand, many discharged as improved ultimately will be cured. He does not state what became of the other 10 per cent.

Turning to the pathological details, the author discusses the effect of the conservative treatment upon different structures involved:

1. Sequestra do not have to be operated upon, because they disappear spontaneously, almost without exception, or are often, as it seems, used for the formation of new bone. That tuberculous sequestra frequently heal, author knows from findings in so-called orthopædic resections of healed tuberculous joints, in which one frequently finds sequestra imbedded in granulation and connective tissue. Bernhard and Rollier point out that the heliotherapy causes the extrusion of sequestra through sinuses. Bier, however, says that he observed an extrusion only in exceptional cases, and that the resorption of the sequestra is a regular occurrence. At any rate, under his treatment, there never occurred the necessity of removing even large sequestra.

2. Extracapsular foci heal spontaneously even if the joint is already infected. On the other hand, even the operative removal of the focus before invasion of the joint, does not protect the latter from becoming infected.

3. Bier states that his x-rays show the disappearance of spondylitic abscesses of the spine. He considers for this reason Albee's operation entirely useless. (!)

A further assertion of Bier's is that deformities of joints, existing during the course of tuberculosis and before the cure is accomplished, can be remedied by his conservative means, as the tuberculous bone is soft and pliable. By this he means the correction of knock-knees, bow-legs, in or outward rotation, subluxation, etc. He furthermore aims to show that there is a high degree of completeness in the regeneration of joints and bones; but even if regeneration is incomplete following severe destruction, the function is often very excellent.

Bier further states that one should not hasten with the establishment of new joints by arthroplasties, in these cases of ankylosis from tuberculosis. He has produced nearthroses after 30 years of ankylosis. If one operates too soon, there is danger of recurrence of tuberculosis.

He has healed by heliotherapy also several forms of lupus, especially erythematoses.

He has healed the capsular fungus of the knee-joint considered so extremely refractory to treatment. And he has also healed the indurated form of tuberculous glands.

One of the difficulties of the treatment is its long duration during which the patient is condemned to idleness.

Of his 1389 patients treated in his institute, 54 or 3.8 per cent. died. Cause of death was as follows:

Amyloid degeneration	18
Meningitis	14
Miliary tuberculosis	1
Pulmonary	6

The rest divided among different conditions.

In defense of his high rate of amyloid death, this author maintains that most of these probably reached his institute when already afflicted with amyloidosis.

Inasmuch as 70 per cent. of all his cases had open sinuses, the large number of amyloidoses may be easily explained.

When the disease has healed both clinically and radiologically, the diseased joints were encased in Hessing apparatus, but without permanent immobilization. They are merely exempt from weight-bearing. In spinal cases, a corset is applied.

The author concludes by pointing out the difficulty of the differential diagnosis which seems to be increasing the more experience one gathers in the field of tubercular disease of bones and joints. This is because of the number of cases of syphilis, gonorrheal arthritis, and Perthes' disease, which constantly simulate the clinical picture of tuberculosis. (This abstract is given here on account of the most unusual and strange view held by this prominent surgeon; the abstractor cannot suppress a feeling of comfort in the thought that he is not responsible for any of these statements.)—*A. Steindler, Iowa City, Ia.*

PARALYSIS

Paralysis in Children Due to the Bite of Wood-ticks. P. D. McCornack, M.D. *Journal A. M. A.*, July 23, 1921.

Adults are rarely affected, practically all cases reported being children. The tick season is from February to August. The ticks are found in British Columbia, Washington, Oregon, Idaho, Montana, Minnesota, Colorado, Iowa, and cases also reported from Cape Colony and Australia. The wood-tick most commonly found is *Dermacentor venustus* which is also responsible for the transmission of Rocky Mountain spotted fever. No parasites have been found and bouillon cultures from diseased animals have remained sterile. Experimentally, paralysis has always been produced through the agency of tick bites, but it has been impossible to transmit the disease by inoculations.

The nature of the disease has not been determined. The inoculation period is from six to eight days. The paralysis may be explained as resulting from toxins absorbed from the ticks and elaborated, especially at the time when engorgement is complete. One attack seems to confer a lasting immunity.

At the point of attachment of the tick subcutaneous hemorrhages are found resembling those seen in hemophilia.

The symptoms come on suddenly in a previously healthy child. Weakness of the muscles of the extremities, rapid pulse, slight rise of temperature and, in a few hours, more or less complete motor paralysis.

Most of the children recover entirely in less than 48 hours after the tick is removed. Death sometimes occurs from respiratory failure. It is necessary to remove the entire tick. The direct diagnosis depends on finding an engorged wood-tick. The only case in which a complete blood examination was made showed an eosinophilia, being indicative of animal parasitic infection.

The tick may be found buried in the scalp, external ear, axilla or some other protected region. Kerosene or chloroform may be used to force the tick to loosen its hold. In the cases in which the tick has been classified, it has been the female.

Among the 14 cases whose histories are given by the author there were three deaths.—*W. G. Elmer, Philadelphia.*

THE ETIOLOGY OF THE PLEXUS PARALYSIS OF THE NEWBORN. Weil. *Archiv. Orth. und Unfall-Chir.*, Vol. 19, No. 2, Jan., 1921.

The author reviews the various theories which have been advanced in explanation of birth palsy.

He begins with the dislocation theory, which, in his opinion, does not come into consideration for the vast majority of cases of birth palsy.

In regard to the so-called subluxation of the shoulder, a condition lately pointed out by Fink, he states that in three of his cases, he distinctly noted an abnormal mobility of the head of the humerus, but he believes that this symptom is to be regarded as the effect of paralysis and not, as Fink believes, as its cause.

Lange has been sponsoring the theory of distortion of the shoulder joint, estimating that in the vast majority of his cases, namely, in 76 per cent., there is a so-called pseudo-paralysis, the cause of which is a distortion of the shoulder joint during birth. The author, however, points out that on the newborn such a distortion cannot be demonstrated.

The theory of Kuestner is that a separation of the epiphysis at the upper end of the humerus is responsible for the condition. The author believes, on the basis of his personal experience, as well as upon the findings in the literature, that the so-called osteo-articular forms of birth palsy, the pseudo-paralysis, have been greatly over-estimated in regard to frequency as compared with true paralysis. In the nine cases of his own observation, eight times paralysis could be demonstrated and only in one case a pseudo-paralysis could be considered present. He believes that in all cases the nerve paralysis is the principle factor and that a large part of the non-paralyzed cases develop from originally true lesions of the plexus. In regard to the direct cause of birth palsy, the author states that the pressure of the forceps can only be responsible in exceptional cases, since the instrument hardly ever reaches Erb's point, but is usually applied higher up. Also regarding the pressure of the finger, such an explanation is forced and cannot be considered of great moment. The large majority of cases of pressure paralysis could only be explained by the pressure of the

clavicle, but the usual case is not caused by pressure but by tension upon the plexus, causing a strain of the nerve roots, especially the fifth and sixth cervical nerve.

However, in disregard of all former explanation, the author advances a new theory for the pathogenesis of birth palsy. He believes that at least a part of these paralyses are not to be considered as birth palsies in the stricter sense, but are really due to intrauterine pressure, occuring, therefore, not during birth, but in utero. He reasons as follows: Birth palsy is not infrequently observed in cases of entirely normal and spontaneous delivery. Also in cases in which operative interference during birth was necessary, it is not infrequent that the arm which is paralyzed offered little difficulty in delivery, whereas, the other, non-paralyzed arm was difficult to deliver. He also points out that there have been observed cases of birth palsies in brothers and sisters. The local findings on the paralyzed extremities are also of importance. Pressure marks, swelling, and hæmorrhages are rarely found. On the other hand, signs of flail joint are often seen on the second and third day after birth. The head of the humerus on the paralyzed side can be displaced forward to an abnormal degree. Furthermore, the x-rays often reveal an abnormal curving of the clavicle and a greater distance between the head of the humerus and the glenoid fossa. He considers it impossible that the flail joint due to paralysis sustained during birth, could develop as early as two or three days later. He also advances the argument that he has found very slight differences in the circumference of the arm, amounting to about one-sixth of an inch, which according to his view, could not be explained unless the paralysis had taken place in uterine life.

Of special importance seems to him the fact that birth palsy is often complicated with other congenital deformities. Among his own material, he has found a child with birth palsy who had a double hip dislocation. One case had a congenital defect of the abdominal musculature. In another case, the birth palsy was combined with a marked congenital scoliosis. Deformities of the head were seen in three cases. Furthermore, combinations of wry-neck were observed in birth palsy by Schüller and Sippel. The author also considered wry-neck as a coördinate congenital deformity. Lange called attention to contractures of the elbows in these cases, and Koenig found in his case a manus valga complicating the paralysis of the right arm. To the author, this case proved with certainty that the paralyzed arm or its nerve supply had been exposed to abnormal pressure during intrauterine life. He considers the contractures in extension or flexion of the elbow,—the inhibition of pro- and supination, the contractures of hand and fingers likewise as proofs of the intra uterine character of this deformity. As far as the fractures of the clavicle and the humerus are concerned which are occasionally observed, he believes these to be a kind of spontaneous fracture due to an abnormal fragility of the bone.

In explanation of the mechanism of the intra uterine development of this deformity, the author is forced to assume the action of two deforming forces: (1) A component acting upon the arm and causing the various position of contracture; (2) A more important component which causes the paralysis. Beyond this theoretical explanation, the author does not venture into the details of explaining how this deformity comes about. (It is to be regretted that the author is not familiar with, or at least has not mentioned, the work of American

authors such as T. T. Thomas, Taylor, and Sever. The questions of the importance of the forceps, of the significance of the flail joint, and many other points mentioned in this paper have been thoroughly discussed by these authors. Especially has it been shown by Sever in rejection of Lange's joint theory that no flail joint has ever been observed earlier than one month after birth.)—*A. Steindler, Iowa City, Ia.*

MISCELLANEOUS

TREATMENT OF ARTHRITIS. Arthur F. Chace, M.D., Victor C. Myers, Ph.D., and John A. Killian, Ph.D., *Journal A. M. A.*, Oct. 15, 1921.

The authors give a brief consideration to the use of the sodium salicylate, cinchophen and neocinchophen in the treatment of acute and chronic arthritis as well as of gout.

A report of eleven cases of acute and chronic arthritis gives the impression that at least in the acute ones neocinchophen did, in a few days, produce cessation of pain and increased ability. In their experience cinchophen and neocinchophen are much more easily tolerated by the stomach and irritate the kidneys much less than the salicylates. The dose of neocinchophen, as employed by them, was 50 grains daily.—*H. A. Pingree, Portland, Maine.*

INFANTILE DEFORMING OSTEOCHRONDRITIS OF THE UPPER FEMORAL EPIPHYSIS. Feutelais. *Revue d'Orthopédie*, July, 1921, p. 315.

A child with negative family and personal history began to limp when about 3½ years old and at the same time an appreciable atrophy of the left leg and buttock was noticed. No pain, except for a very short period at the beginning. The limp resembled that of a dislocated hip or a coxa vara. Motion in the left hip to normal limits except that abduction is very sharply limited. (Rotation is not mentioned.) The roentgenogram showed a slight coxa vara and the epiphysis reduced to a thin plate of tissue in three pieces. The acetabulum showed roughening on its superior surface.

The child had no immobilization of the hip but went about as a normal child. After two years there was no more limping except perhaps in wet weather. The child was so well that the mother did not worry any more about it.

In this case there was no trace of infection found and no history of trauma. It was not congenital. The affection is regarded by the author as a defect in osteogenesis and as probably analogous to imperfect development of the tarsal scaphoid which is frequently seen in young children.—*William Arthur Clark, Pasadena.*

LOOSE BODIES IN JOINTS. A. G. T. Fisher, *Lancet*, April 23, 1921.

Loose bodies of cartilage or cartilage and bone may be divided in three groups:

1. Loose bodies occurring in connection with some general pathological process affecting the joint such as (*a*) osteo-arthritis, (*b*) tabes, (*c*) tuberculous disease accompanied by an necrotic caries, (*d*) acute arthritis due to infection.

2. Loose bodies occurring in joints that are otherwise apparently normal; (*a*) bodies having the microscopic appearances of detached portions of the articular surfaces, (*b*) bodies derived from inter-articular fibrocartilages, (*c*) bodies formed from detached epiphyses not forming portions of an articulating area.

3. Synovial chondromata: (*a*) single, (*b*) multiple, (*c*) diffuse.

In cases of loose bodies formed from detached osteophytes, they may be recognized if seen early, but later this fractured surface may be covered by an outgrowth from the surrounding cartilage. A section through the entire body shows that the periphery consists of well developed fibro-cartilage with comparatively few, but uniformly distributed cells. The bone in the center is quite dead. The lacunae are empty, and devoid of any staining elements. Detached epiarticular ecchondroses grow from the articular margins and might arise in the substance covering the normal bone. This takes place by local hyperphasia of the cartilage, in which central ossification subsequently occurs.

The loose bodies in tabes involve the formation of bone in the planes of connective tissue between the capsule and the synovial membrane so that the joint may be surrounded eventually by bony masses.

Loose bodies are rare in tuberculosis, and are formed most frequently from the articular end of the femur and are probably due to the interference with the blood supply.

Loose bodies in otherwise normal joints are most frequently found in adults between the ages of fifteen and twenty-five. The joints affected in order of frequency are knee, elbow, shoulder, hip, ankle, and wrist. These are usually single but may be multiple. The condition may be bilateral and in most cases there is a definite history of trauma.

When a loose body has been detached recently, microscopic examination shows the cartilage and bone to be living. When less recently attached the bone cells are dead but the cartilage cells usually show marked proliferative changes. If detachment is incomplete or if secondary adhesions have formed new bone may develop. Loose bodies may also be derived from inter-articular fibrocartilage, especially the semilunars.

The synovial chondromata are intimately connected with neoplasms. They originate from the cartilage cells in the synovial villi.

After a study of clinical, pathological, and experimental data, trauma is found to be a very frequent and in most cases the exciting cause of the condition. The interval between time of injury and the onset of the symptoms may be explained by incomplete detachment of the body or its subsequent detachment elsewhere. Only when free to impinge between joint surfaces does the loose body cause symptoms of pain and locking.

The cartilage cells retain their vitality—bone cells do not. It is important to remember this in cases of grafting. The author suggests the preservation of periosteum in order that an early vascular connection may be established.

The treatment advised is removal of the loose body. The prognosis is good in the young and middle-aged where the joint is otherwise normal. If the traumatic loose body has been allowed to remain in the joint long enough to cause chronic villous arthritis or commencing osteorthritis, although we may

cure the sudden attacks of pain due to the body becoming impinged between the articular surfaces, yet the operation may be followed by pain, swelling, and a feeling of weakness in the joint due to the superimposed condition. The results of operation in the synovial chondromata are also good, provided the condition is not progressive.

At operation a liberal incision should be used, and an x-ray examination taken in two planes will show us how and where to open the joint. The author advises again the older method of transfixion of the loose body and removal through a small incision.—*LeRoy C. Abbott, Ann Arbor, Michigan.*

Diagnostic and Therapeutic Point in Retrocalcanean Bursitis. A. L. Nielson, M.D., *Journal A. M. A.*, Aug. 6, 1921.

The cause of the disease is an inflammation of the bursa lying between the insertion of the Achilles tendon and the tuberosity of the os calcis. Of special infections, tuberculosis occurs and readily extends to the bone. Gonorrheal infection attacks this bursa, as do rheumatic infection. In chronic infections there is thickening of the endothelial lining, cartilaginous hypertrophy and periostitis, with formation of exostoses.

The causes of the disease are overuse of the foot, pressure of shoes and bacterial infection. There is local pain on motion and tenderness over the bursa. There may be a swelling on each side of the Achilles tendon. The pain is caused by pinching the bursa between the tendon and the os calcis on flexion of the ankle.

The treatment consists in adding ¾-inch rubber heels to the ordinary low-heeled shoes and careful fitting of the shoes to prevent pressure. If this does not succeed the bursa must be dissected out.—*W. G. Elmer, Philadelphia.*

Some Observations on the Static Influence of Shortened Pelvic Muscles. John Joseph Nutt, M.D. *New York Medical Journal*, Oct. 19, 1921.

The author reports five cases with complaint of pain in the back, hips, and thighs, made worse by any exercise, in which there was limitation of thigh flexion and extension, of thigh abduction, and in some, shortening of the gastrocnemius, without any structural changes. He comments that he has in a number of cases found the cause of round shoulders and other postural faults to be limitations of normal movements of the pelvis.

In the cases reported the symptoms were relieved by systematic passive stretching of the contracted muscles.—*Dr. C. L. Lowman, Los Angeles.*

BURSITIS CALCAREA OF THE EPICONDYLUS EXTERNUS HUMERI; A CONTRIBUTION TO THE PATHOGENESIS OF EPICONDYLITIS. J. Schmidt. *Archiv. Orth. und Unfall-Chir.*, Vol. 19, No. 2, Jan., 1921.

In 1896, Bernhardt described an affection of the external epicondyle of the humerus which he classified as occupational neuralgia. The principle symptom was a sharply defined tenderness upon pressure on the external epicondyle. Other symptoms were a feeling of weakness of the forearm and functional disturbance, especially in regard to rotatory and extensory movement. The condition was described and recognized by others. Franke regarded it as a localized ostitis of the external epicondyle. Clado explained the condition as a tear in the supinator brevis. Baehr considered it as due to a tear in the ligamentous apparatus. Preiser regarded it as a lesion of the ligamentum collaterale radiale caused by simultaneous and violent contraction of the brachialis internus and supinator brevis.

The author describes a case of his own observation: a woman 34 years old complained of violent pain on the outer surface of the left elbow. Four years previously she strained her elbow by lifting a heavy object. Two years later there appeared on the outer surface of the left elbow a node, which a short time later became painful. The pain appeared on extension of the forearm as well as on rotatory motions, and radiated into the dorsum of the hand.

He found on the outer surface of the left elbow joint over the external epicondyle a painful fluctuating tumor the size of a bean. The x-ray picture showed a shadow separated from the epicondyle and sharply defined. Under local anaesthesia, an incision was made over the tumor which appeared to be a cyst filled with detritus. It was separated from the external epicondyle and removed. Examination of the cyst showed its contents to be masses of calcium carbonates and phosphates. The walls of the cyst were in a condition of chronic inflammation.

Of the subcutaneous bursae of the elbow, only the bursa olecrani is a constant structure. A bursa over the internal condyle is found according to Gruber in one out of ten adults. A bursa over the external condyle is still more infrequent, being found in only one out of 60 individuals.

In the case described, the eliciting cause seems to be a trauma sustained four years previously.

The formation of the bursa with calcareous contents may be explained upon this basis: the chronic inflammation of the neighboring structures,—in this case, a circumscribed periostitis at the external epicondyle,—causes a chronic inflammation of the walls of the bursa or a chronic bursitis. In this respect, there is a considerable analogy with the subacromial bursitis which is responsible for the periarthritis humeri; on the basis of a strain of the arm from lifting in the position of flexion and supination. It may then come to a distortion of the collateral ligament of the radius, followed by periosteal bone apposition and involvement of the bursa in a calcifying bursitis over the external epicondyle of the humerus.

(The author is not aware that a condition of this kind has been described lately by Osgood under the name of tennis elbow.)—*A. Steindler, Iowa City, Ia*

MULTIPLE OSTEOCHONDROMATA. Bernard Pierre Widmann, M.D. *Am. Jour. of Roentgenology*, August, 1921.

The author reports one case of this condition, which he defines as "The occurrence of multiple, more or less symmetrical, cartilaginous and osteo-cartilaginous growths, within and on the skeletal system, generally benign and resulting from a disturbance in the proliferation of bone forming cartilage."

Heredity evidently plays a considerable rôle in the transmission, and tuberculosis is frequently associated, which association may be significant.

In the case reported, a boy of 13, there was neither hereditary nor tubercular element, nor any significant previous sickness. He began to present bony enlargements at four years of age at the wrists, knees, ankles, over the clavicles and the inferior angles of the scapulae. There were no subjective symptoms.

The roentgenologic examination showed disturbance in the ends of the diaphyses of all the long bones, even the ribs, in the nature of thickening or tumor formation, having the characteristics of bone: *i. e.*, cancellous tissue, regularly arranged, with no destructive effects and none of the appearances of true tumors.

Two cases of multiple exostoses are on record, in which there were endostoses pressing on the central nervous system, causing pressure symptoms.

The author's conclusion is that this condition is a constitutional disease, primarily a disease of the endocrine system, and with an hereditary tendency.—*C. L. Lowman, Los Angeles.*

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SPONTANEOUS HEALING INHERENT IN TRANSPLANTED BONE.

BY S. L. HAAS, M.D., SAN FRANCISCO.

From the Surgical Pathological Laboratory of Leland Stanford, Jr., University School of Medicine.

It is still contended by some investigators and surgeons that bone after transplantation dies and takes no share in the process of restoration, but functions merely as an inert body, by serving as a framework for the ingrowth of live bone with which it is in contact. By those who hold this view it is further claimed that it is immaterial whether one uses live or dead bone, from the same or some other animal or even a foreign substance for the transplantation material. This idea persists, in spite of the fact that it has been repeatedly shown that there takes place in bone after transplantation definite signs of proliferation from the periosteum, endosteum, and from the lining cells of the Haversian canals. This non-acceptance of the doctrine that a live bone transplant shares in the regenerative processes must be due to the fact that the evidence thus far submitted is not sufficiently convincing to those who hold the opposite view. Therefore, in order to unify our conception regarding this important principle concerned with bone surgery, additional proof must be submitted of the independent activity of osteoblastic tissue after transplantation.

The healing of a fracture calls into play practically every component part of bone and makes as severe a demand upon the reconstructive activities of its various cellular elements as any pathological process

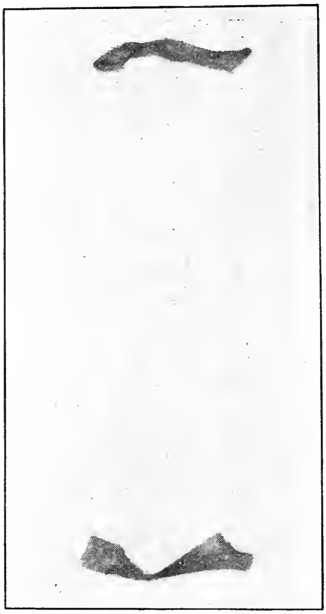

FIG. 1.—Roentgenograms, in planes at right angles, of a phalanx which was completely fractured and then buried in muscle. The bone, which was removed at the end of 73 days, shows complete union of the fracture. Notice the absorption of the bone, resulting from lack of functional stimulation.

of bone. It was, therefore, considered as a suitable test to determine if the cells of bone possess an independent power of proliferation after transplantation, by studying the behavior of the cellular elements and their response toward the healing of a fracture in transplanted bone. In order to guard against the influence of any other osseous tissue, it was essential that the transplant, after fracture, be placed so as not to be in contact with other bones. Therefore, if an entire bone is removed and after being fractured, placed in the muscles of the back, any tendency toward healing of the fracture must be ascribed to the independent proliferative power of the cells of the transplant; and should there be a definite union of such a fracture in a transplant to muscle, then I believe that the most skeptical will have to admit the importance of the inherent activity possessed by osteoblastic tissue after transplantation.

With the above object in view a number of experiments were performed upon dogs, two of which will be briefly reported at this time. All of the experiments were performed under general anæsthesia with the usual aseptic technique.

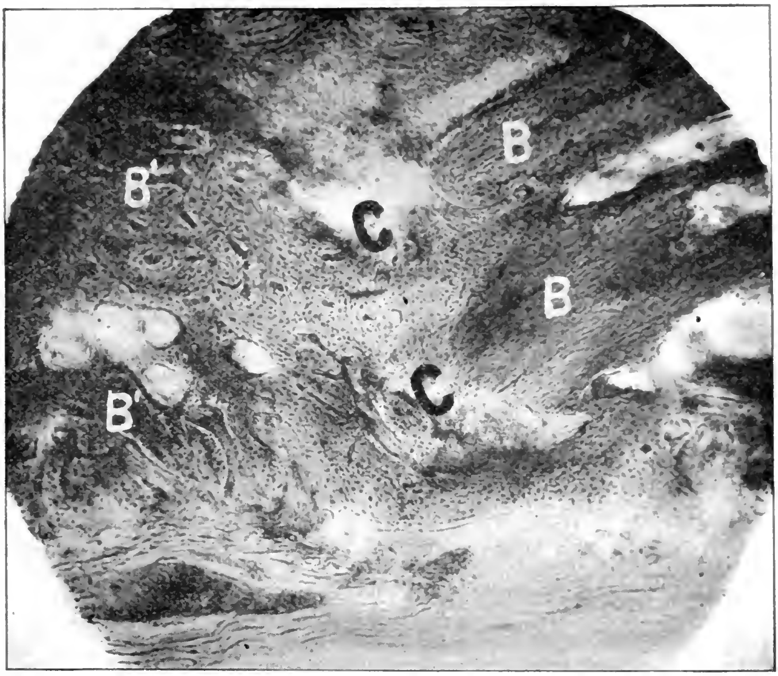

FIG. 2.—Microphotograph of a section through the site of union, of the healed fracture in the transplanted phalanx, removed from the muscles of the back at the end of 73 days. Notice the old bone at *B*, with the intervening new bone, *C*, which is the result of the inherent proliferating power of the cells of the transplant. This section is through the narrow neck of bone shown in the roentgenogram, Fig. 1.

EXPERIMENT 1.—Dog 1.—Full grown. Duration of experiment, seventy-three days.

Operation.—The first phalanx of the fourth toe of the left hind foot was removed intact. It was then fractured completely through the center and after the fragments were placed in apposition they were transplanted to the muscles on the left side of the spine.

Macroscopical Findings.—Seventy-three days. The bone was found encapsulated in the muscles of the back. It was considerably thinner than normal and had evidently undergone absorption. The two fragments appeared to have firmly united. The roentgenogram (Fig. 1) shows two views taken at right angles, and one can see a definite osseous bridge connecting the two fragments.

Microscopical Examination.—A study of the sections shows a definite continuous osseous tract from one articular cartilage to the other. The minute cellular changes will not be discussed in this paper, but one can distinguish the old and new bone at the site of union. The microphotograph (Fig. 2) shows a section through the field of union of the fragments.

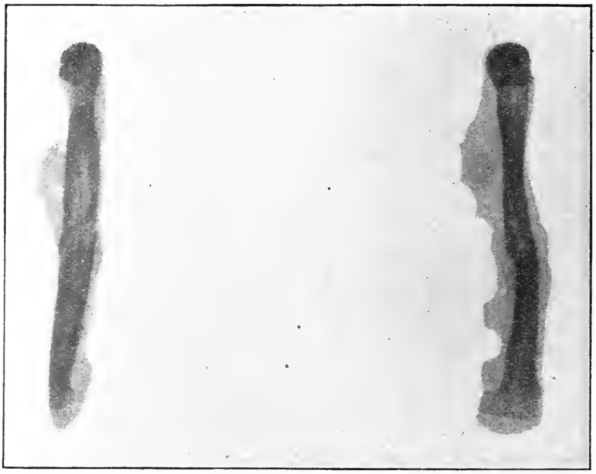

Fig. 3.—Roentgenograms, in planes at right angles, of a metatarsal bone that had been fractured in the center and transplanted to the muscles of the back. The bone was removed at the end of 71 days and showed firm union. Notice the bridging of the bone at the fracture plane. The bone is undergoing absorption.

Deductions.—The two fragments of bone after transplantation possessed the same tendency toward healing as two fragments of a fracture in a normal position. From the study of other experiments it can be stated that the process is identical, and union takes place after the formation of a cartilaginous callus, which later undergoes ossification. Because of the fact that the bone is transplanted to muscle, is removed from any possible influence of extraneous osseous tissue, any changes taking place must be ascribed to the energy that is stored in the cells of transplant itself. On account of the bone being removed from the influence of normal functional stimulation, there will take place a slow degeneration after the initial active response.

Experiment 2.—Dog 3.—Young, full grown. Duration of experiment, seventy-one days.

Operation.—Removed the entire fourth metatarsal bone from the right hind foot. The bone was fractured completely across the center, except for a small strip of periosteum, and then buried in the muscles on the left side of the spine.

Macroscopical Findings.—At the end of seventy-one days, the bone was found encapsulated in the muscles and was smaller than when it was inserted. The union of the fragments is firm and there is very little evidence of any callus. The roentgenogram (Fig. 3) shows the line of fracture, which in places is bridged by new bone.

Microscopical Examination.—A section through the bone at the site of the fracture (Fig. 4) shows, on one side, a definite osseous connec-

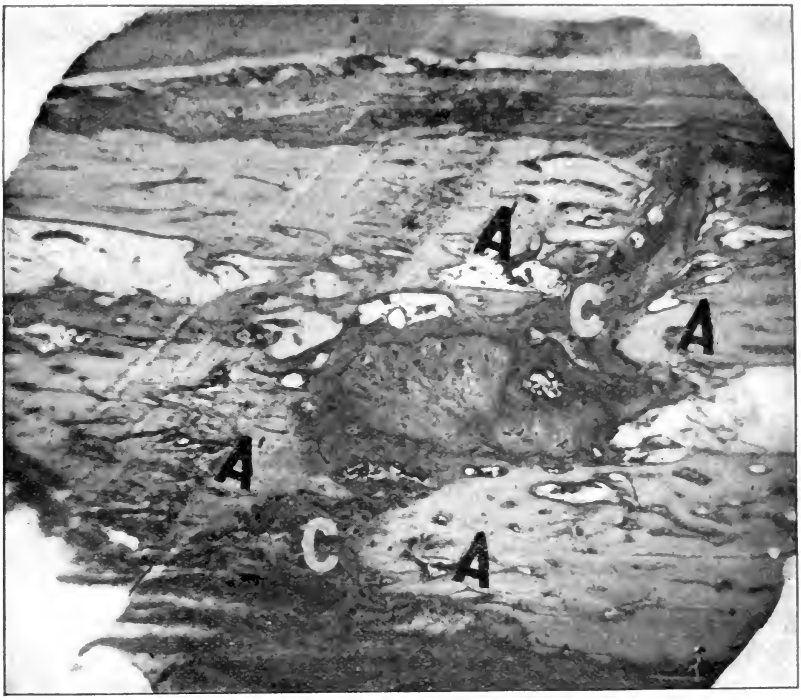

FIG. 4.—Microphotograph of a section through the site of union of a fracture in a transplanted metatarsal bone removed from the muscles of the back at the end of 71 days. *A*, *A'*, the old bone fragments. Notice the loss of nuclear staining and degenerated appearance. *C*, *C'*, new bone at the fracture line. This is also undergoing degeneration. After the initial degeneration with union of the fragments there takes place a secondary degeneration because of the lack of functional stimulation.

tion between the two fragments. In spite of the union and evidence of proliferation, the osseous tissue of the original bone, as well as of the callus, has lost the greater part of its nuclear staining. This is undoubtedly due to a secondary degeneration.

Deductions.—The condition here suggests that there was an early regeneration and formation of a callus. Then, again, because of the lack of functional stimulation a final degeneration took place.

GENERAL SUMMARY.

Bone when transplanted into a muscular bed, and thereby removed from any possible influence of other osseous tissue, shows definite signs of cellular activity. It has been previously shown,[1] that even though there is an initial degeneration of the greater part of a transplanted bone, that a sufficient amount of osteoblastic tissue survives

in the region of the periosteum, endosteum, and about the Haversian canals, to regenerate the new bone. Furthermore, if the transplanted bone is not subjected to functional stimulation[2] it will gradually undergo a second and permanent degeneration.

In the case of transplanted bones in which fractures have been produced, there is made an additional demand upon the regenerative powers of osteoblastic tissue. This demand is complied with in just such a way as normal bone responds to the call for the repair of a fracture, namely: the formation of cartilaginous callus which later becomes ossified. This response takes place, even though the bone is removed from the normal functional stimulation, but on account of the lack of functional demand it, too, undergoes degeneration.

In view of the fact that the osteoblastic components of a transplanted bone possess sufficient energy to produce the union of a fracture, even when buried in muscle, there must be ascribed a considerable importance to the regenerative powers of the cells of such a live piece of bone.

CONCLUSIONS.

1. There is sufficient energy stored in the osteoblastic cells of a live bone transplant, placed in a muscle and removed from all osseous contact, to form a union between two fragments of a fracture produced in such a transplant.

2. Because of this very active, independent, regenerative and reparative property innate in the live bone transplant it is advisable to utilize living bone, whenever possible, for any purpose where a transplant is indicated.

(I wish to extend my thanks to Professor Blaisdell for the privileges granted to me during this experimental study.)

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NOTE ON SACRALIZATION OF THE FIFTH LUMBAR VERTEBRA.*

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Of late years the condition known as Sacralization of the Fifth Lumbar Vertebra has come into considerable prominence on account of the fact that radiography has thrown its beam of light upon a condition about which previously very little was known, and which most certainly is entirely undiagnosable without an x-ray examination and is rarely if ever suspected of being present from any symptoms which may be complained of.

Until recent years there was very little literature on the subject, and practically all there was was purely anatomical. Thus the Index Medicus from 1917 to 1920, inclusive, gives no references under the heading of Sacrum or Sacralization, but in 1921 a considerable number of papers are recorded.

The late Professor Paterson, of Liverpool University, published a monograph in the *Scientific Transactions of the Royal Dublin Society* in 1893, on the Sacrum—*i.e.*, two years prior to the discovery of x-rays. He points out in this paper, which is a very elaborate one, that the lateral mass of the sacral region equals (or represents) the transverse processes and ribs of the thoracic portion of the spine; he figures two unilateral and three bilateral cases of sacralization, and one embryo of seven months with the unilateral condition.

Young, in the *American Journal of Orthopaedic Surgery*, in 1916, on the x-ray examination of the lumbo-sacral region, notes that congenital irregularities have long been recognized and that irregular formation of one or both transverse processes of the fifth lumbar vertebra has been considered as a frequent etiological factor in scoliosis. He also notes that the irregularities of the deposit and development of the centers of ossification of the fifth lumbar vertebra are so variable that the late Professor Thomas Dwight was doubtful as to what should be considered the normal.

Japiot, in 1914, when reporting two cases of sacralization, states that at that time he could find only five references in literature. Since that time, however, there have been a large number of cases reported.

* Paper read before the British Orthopaedic Association at the Annual Meeting, held in Liverpool on December 2nd, 1921.

For instance: Rossi (Italy) in 1917–1918 reported 22 cases; Richard (America) in 1918, 54 cases; Nové-Josserand et Rendu (France) in 1919–1920, 19 cases; Japiot (France) has radiographed at least 20 cases, whilst during the last twelve months a great many authors—chiefly French—have placed on record numerous cases.

The condition, as far as I know, has received little or no attention in England, and I have not been able to find any reports of cases or any radiographs of this condition in our journals. In Ireland, however, Hayes (Dublin) has reported four cases in the *Dublin Journal of Medical Science,* in the April number, 1921. He also states that no case of operative treatment resulting in a complete cure has been reported.

It is evidently a common condition, and one, I think, which requires a certain amount of surgical consideration, in view of the undoubted fact that pain of some kind or another is so frequently present in the cases in which the deformity is found. Always admitting the somewhat voracious appetites of the orthopædic surgeons during the past few years, I take it that this condition may be justly considered as a part of their regular diet; this must be my excuse for bringing it before you.

I have seen ten cases during the present year, and produce radiographs of these cases: eight in females, two only in males. The ages vary from 2½ years up to 59 years, three in children of 10 years and under, the remainder in adults. The one in a child of 2½ years is of interest inasmuch as it shows the development of the lateral masses of the sacrum from separate centers, and complete fusion has not yet taken place. Five cases are symmetrically bilateral. Five cases are unilateral. In four of these there is an abnormal appearance of the transverse process on the opposite side.

The symptomatology is of some interest. Pain in the region of the back is what is usually complained of in most of the cases in which this condition has been discovered radiologically, but in one of my cases the discovery was entirely accidental, as no pain whatever which could have had any relationship to the presence of sacralization was complained of. The radiograph was taken because pus had been discovered in the urine. Others have also noted that the condition may be painless. We also have the fact, of course, that existing from the time of development, the condition may be painless for a large number of years and the history frequently given is pain for a few years only, or for even much less.

Probably the usual diagnosis in these cases at first, at any rate, is lumbago, and no doubt many continue for years and have the usual treatments given for this complaint. Osteoarthritis of the lumbar spine would also have to be considered. However, by far the larger number of cases—all mine except one—are sent to the radiologist with a request for an x-ray examination of the kidneys, ureters, or bladder, the suspicion being that the pain may be caused by stone. In none of my cases was a stone present.

It does not necessarily follow that the pain in these cases is due to the sacralization, but that after all is, and can be, only an inference; but the cause of the pain is generally obscure and the pain itself is indefinite in character, so that in the absence of any other known cause, and in the presence of an otherwise negative x-ray examination, it seems fair to suspect the only abnormality which can be found, namely, the sacralization, as a probable cause of the trouble.

Two questions arise: Why should it give rise to pain? Why can it exist for many years without pain and then, in some cases, give rise to a pain which begins slowly, and gradually gets worse and worse, and in others commences with an attack of acute pain?

Various causes have been put forward, and these may be summarized as follows:

1. Actual pressure on nerves or nerve trunks.
2. Ligamentous strain.
3. Compression of soft tissues between bony joints.
4. By an actual arthritis if a joint is present.
5. By a bursitis if a bursa is present.

There is the additional point that a trauma may be the exciting cause, especially in those cases of sudden and acute pain.

In one of my cases, which I shall refer to again, I consider that the radiograph distinctly suggests a definite joint, and also indicates an osteoarthritis. This was a unilateral case, with pain on the side of, and in the region of, the abnormality.

As to the treatment of this condition: Els (of Bonn) advises operation in pain from definite sacralization; Merklen and de Gery (Paris) advise resection, but state that up to the present (1920) the results are not very striking; Japiot (Paris), 1921, states that in four operations performed in America, only amelioration, and not cure, resulted. He himself has treated the pain by x-ray therapy with promising results. (As a comment of this, it is extraordinary what a lot of conditions have been treated with x-rays with "promising results.")

I take it that cases for operation should be very carefully selected, and that to jump at operation merely on the x-ray findings would be absurd. There should, at any rate, be some definite grounds for the assumption that the condition in each individual case was the probable source of the pain. My material bearing on this matter is small but, at the same time, significant. One case, a woman aged 30 years, in a medical ward of the Royal Infirmary, was referred to me by Dr. Abram for an examination of the kidneys. In the routine of this examination, nothing was found, but a unilateral sacralization plus a somewhat abnormal transverse process on the other side, were shown. This is the case already alluded to as suggesting a joint plus osteoarthritis. The pain—twelve months' duration—was definitely on the side of the sacralization. Knowing at that time nothing about the subject, I naturally rushed in where angels fear to tread (I, of course, refer to yourselves, gentlemen), and suggested an operation.

A few weeks later an osteotomy and removal of bone was done by Mr. Jeans. Four months later, in reply to enquiries, I received the following letter: "I am pleased to say that I have had no return of pain since, and have been much better in health. I will take this opportunity of thanking all those who helped to restore me to health, and I cannot say how grateful I am."

One case of success is, of course, not very much to go upon, and even in this case no great length of time has elapsed since the operation. At the same time it has its significance, and I suggest that the condition of sacralization deserves your attention.

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A NEW METHOD OF OPERATIVE TREATMENT OF FOOT DEFORMITIES.

BY O. E. SCHULZ, M.D., PRAGUE, CZECHOSLOVAKIA,
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THE correction of a faulty position of calcaneus is a matter of greatest difficulty in both congenital and acquired deformities of the foot. The correction of the heel might be performed instrumentally or manually, but it is the retention of the corrected or overcorrected position which is so extremely difficult.

In correcting the deformity of the forefoot by redressement, we force the small bones of the forefoot one against the other one, but in the heel we find only one hard and very solid bone, deformed in its structure and form, joined by means of strong ligaments to the astragalus, fibula, and tibia. Such a bone is not easy to correct.

Unfortunately, a recidive of club or flatfoot begins always in the heel, which first goes back to its former wrong position. For this reason a perfect cure is secured only by an overcorrection and retention in the overcorrected position of the calcaneus.

In flatfoot we have corrected the deformity by osteotomy. *Gleich* made an oblique osteotomy of the calcaneus from the front and inside to outside and backward. Then he pushed the rear fragment forward and inside and finished the operation by achillotenotomy. *Brenner* performed the same operation from the inside. *Frisch* proceeds from the outside and nails the processus posterior calcanei from behind. *Perthes* cuts out a piece of the os naviculare and implants it in a linear osteotomy in the processus anterior calcanei. *Wilms* does a similar operation, implanting the piece between the os cuboideum and the calcaneus.

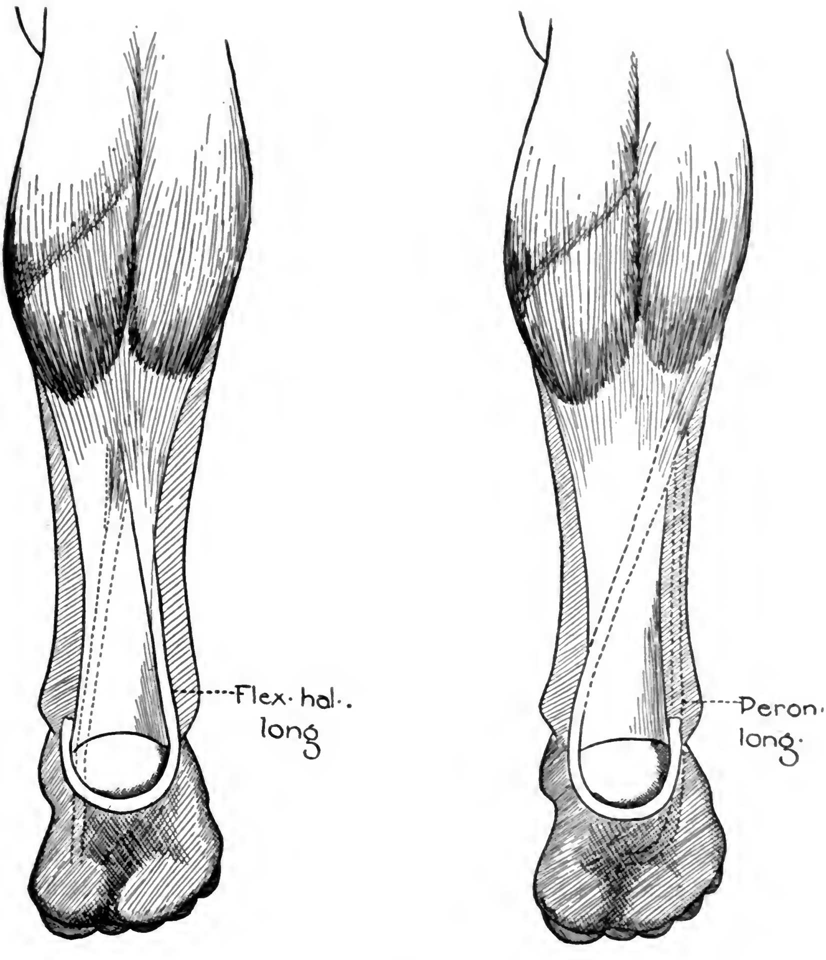
Lorenz, four years ago, recommended a simple operation. He made a skin incision against the Achilles tendon, stripped the skin out and inside of the tendon, chiseled away the insertion of the tendon with the epiphysis of the os calcaneum, pushed the tendon with the fragment outward in case of a clubfoot, inward in a flatfoot, and finally fixed the bone in the overcorrected position by a nail.

The purpose of all these operations is the supination and adduction of the heel. Following the same purpose *Franke Frank, Vulpius* and others shortened the tendon of the musc. tibialis posterior, *Hübscher* shortened the tendons of the flexors of the toes, *Ryerson* transplanted the musc. peronæus longus on the os cuneiforme; *T. R. W. Armour, C. B. Edin* and *Naughton Dunn* excised a portion of the peronæus tendon and paralyzed artificially the nervus peronæus.

All these transplantations have only an indirect influence upon the heel, the new insertion of the transplanted tendon working directly in the elevation of the inside of the foot and only indirectly in the supination of the heel.

My aim was to produce a supination of the heel by means of a strong tendon and at the same time to secure the important adduction and inward rotation of the heel. For this reason I worked out the following method:

I cut the tendon of the musculus peronæus longus in the sole, pull out the dissected tendon behind the malleolus externus and conduct it inside between the gastrocnemius and the flexor of toes to the hind part of malleolus internus. Then I make a canal between the plantar side of calcaneus and ligamentum plantare longum and carry the tendon backward under the calcaneus to the outside, where I fix it to the periosteum of the lateral side of the calcaneus. At the same time I produce an inward rotation, adduction, and supination of the heel. The tendon of the musc. peronæus longus has now its route from outside to inside,



Tendon Operation for Foot Deformity.

returning back to the outside under the calcaneus. A contraction of the transplanted tendon will produce a strong adduction, supination, and inward rotation.

OBSERVATIONS.

I. Girl, 12 years. Poliomyelitis at the age of four years. Right foot is in abduction, heel in abduction and outward rotation. Musc. tibialis posterior and flexor digitorum are paralyzed. Tibialis anterior, extensor digitorum and both peronæi in a pretty good condition. Operation: 1. Incision on the outside of the foot; both peronæi cut. 2. Long incision behind the malleolus externus. 3. A similar incision behind the malleolus internus. 4. The tendon of the peronæus longus pulled out behind the malleolus externus. Both tendons carried through the space between the musculus gastrocnemius and the flexors to the inside. The peronæus longus tendon conducted back to the outside under the calcaneus. The heel adjusted to a maximum of adduction and supination. The free end of peronæus brevis fixed with silk to the periosteum of the inner side of calcaneus, peronæus longus to the outside of the same bone. Incisions sewn with catgut. Plaster dressing in the overcorrected position. Two months later: Foot in a good position; patient walks with her foot in supination. Eight months later: Condition same.

II. Girl, 5 years. Poliomyelitis when one year old. Left foot in abduction, outward rotation, and pronation. Musculi tibialis anterior, flexor hallucis longus, and tibialis posterior paralyzed. Extensor digitorum and peronæi in an excellent condition. The last named muscle is very well developed and dislocated to the front of malleolus externus.

The same operation performed with the exception that only the peronæus longus was cut.

Three months later: The child walks without difficulty in orthopædic shoes with a light support (inlay). Foot in good position.

If we now turn to consider the question of clubfoot we find that the calcaneus deformity is here also of the same importance. *Hansen* recommended the excision of a wedge from the lateral portion of the calcaneus with the angle to the inside and infraction of the calcaneus in an overcorrected position. The operations of *Perthes, Wilms,* and *Lorenz,* can easily be modified to the treatment of a clubfoot. Also the operation which I suggest in this paper can be applied to a clubfoot. The tendon of the musc. flexor hallucis longus is cut in the sole, conducted behind the malleolus externus and back to the inside of the heel under the calcaneus.

Observation: Female, 28 years. Poliomyelitis at the age of 4 years. Double clubfoot. Operated at the age of 18 years by redressement. Fibula was broken in both extremities and its distal fragment became dislocated so much that the malleolus was too large for the astralgalus. A few weeks later both feet returned to the same position. Walking possible only with the help of a strong and elaborate apparatus.

I first made an instrumental and manual redressement of both feet and applied a long plaster dressing in an overcorrected position for ten weeks. After this time the patient could walk without any apparatus, in orthopædic shoes only. Foot was in a good position while the patient was standing. During walking the unfirm foot turned outwards.

Six months later the transplantations were made.

Operation on the right foot:

(1) Incision in the sole, 2 inches long, in the center of the first metatarsal. The tendon of the flexor hallucis cut near the junctura tendinum. The distal fragment of the tendon attached with silk to the flexor communis, the proximal end loosened from the junctura tendinum.

(2) Long incision behind malleolus internus. Ligamentum lanciniatum cut. The free end of the tendon pulled out.

(3) Long incision behind malleolus externus. The tendon carried between musc. gastrocnemius and flexor digitorum to the outside.

(4) The canal under the plantar side of the calcaneus prepared. The tendon carried through the canal under the calcaneus to the inner side of this bone and fixed there with silk. Overcorrection of the heel position at the same time.

(5) The tendon of the musc. tibialis ant. was transplanted to the lateral side of the foot.

Operation on the left foot performed in a similar way. Here the tendon was too short and allowed a fixation to the outside of the calcaneus only.

Plaster dressing on both extremities for 10 weeks.

After 10 weeks: The patient walked without any apparatus for three-fourths to one hour without difficulty. Only walking up hill was painful.

The position of the right foot is better than of the left foot, as was expected.

Summary: A new operative treatment of foot deformities is described, based on tendon transplantation of the heel.

EARLY WEIGHT-BEARING IN THE TREATMENT OF AMPUTATIONS OF THE LOWER LIMBS.

BY PHILIP D. WILSON, M.D., BOSTON.

A SUFFICIENT time has passed since the termination of the war to allow us to draw definite conclusions as to the real value of certain surgical procedures which were introduced at that time. Of these the use of weight-bearing in the after treatment of amputations of the lower limb seems definitely to have proved its value and deserves to be applied to the surgery of peace.

Early weight-bearing is obtained by the use of peg legs or articulated limbs of such simple type and construction that their rapid manufacture is possible by almost anyone after a little practice without the necessity of elaborate training or equipment. The apparatus consists essentially of two parts, a socket which is moulded to the stump in order to obtain an accurate fit, and a skeleton frame which transmits the body weight from the socket to the ground.

The chief bearing points utilized are the bony prominences: the tuberosity of the ischium for thigh amputations, and the shelving under surface of the upper end of the tibia in below-the-knee cases. Secondarily, the weight is borne by the soft parts, but always in a manner to relieve the wound of pressure, the lower end of the socket being left open for this purpose.

The socket may be made of papier maché, leather, or plaster of Paris; the frame is usually of wood or light iron. To work successfully the apparatus must combine the following features,—adaptability to various types of stump, strength, lightness, and ease of manufacture.

With such forms of apparatus it is possible to get patients out of bed and walking without other support very shortly after amputation. When the wound is clean, weight-bearing may be begun at the end of two to three weeks. In the writer's experience the time has often been less. Only serious complications should prolong it more than four weeks. Crutches delay progress and should not be allowed. When support is necessary, canes suffice and are not productive of bad habits. There is no pain when the apparatus is properly designed and fitted, other than moderate soreness of the bony prominences until they become accustomed to pressure.

I.

Thigh peg leg. Stump covered with stockinette and cardboard cuff at end. Crutch frame being applied for preliminary fitting.

Because of this, however, and also because of the great muscular weakness, use should be begun gradually. At first the patient is encouraged to take a few steps supported by attendants. Later, as he becomes stronger, he may push a chair about the room until he has obtained sufficient confidence to walk unaided or with a cane. Short and frequent periods of exertion with long intervals of rest are better than prolonged efforts and over-fatigue. During the first few days the patient is timid and discouraged and it is essential that the surgeon should maintain close supervision in order to give the patient confidence and stimulate him to further effort. The ability to walk is usually acquired within a week, and thereafter progress is rapid. Little attention is required from the surgeon beyond changing the

II.

Thigh peg leg. Plaster has been applied to stump while traction was being exerted on the long end of the stockinette. Upper ends of the crutch frame have been covered with plaster ready for incorporation in the cast.

III.

Thigh peg leg. Cast finished. Note roller bandage in fork of crutch to prevent it from springing together and indenting the plaster.

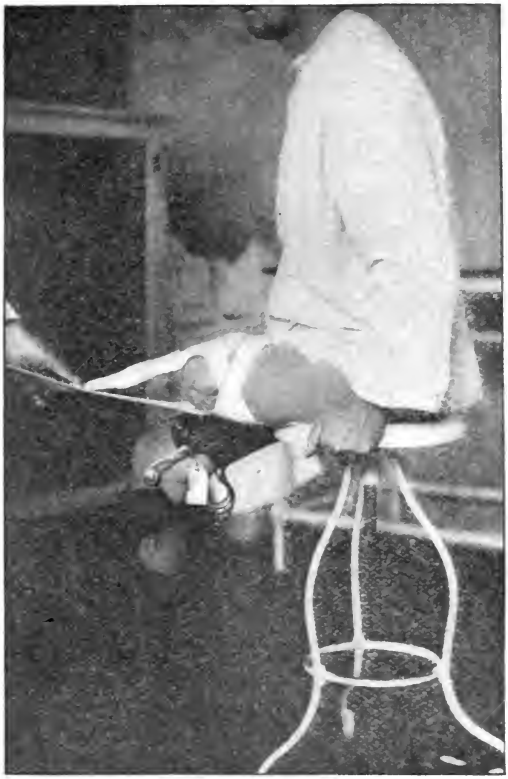
socket when it becomes too large, and restraining the patient from acquiring his permanent artificial limb too early. The use of the temporary prosthesis is continued until the permanent limb has been obtained.

The benefits derived from this method of treatment are varied and may be considered as either physiologic, economic, or psychologic.

1. *Physiologic.* The results may be noted here as they affect first the wound and second the stump.

1. Effect on the wound. Following amputation there is always marked edema of the stump, chiefly noticeable about the wound or distal portion. Wound healing is notoriously slow and sinuses often

IV.
Thigh peg leg. Cast dried, trimmed, and applied.



V.
Application of traction to thigh stump to protect wound when pressure is borne. The ends of the straps are pulled down and buckled tightly to the lower end of the peg leg.

persist for a surprisingly long period. This condition is due to circulatory stasis and may be partially relieved by elevation of the part, massage, and tight bandaging. Active weight-bearing in a temporary limb with carefully fitted socket gives far more effective stump compression, however, than the most carefully applied bandage, and the alternate application and withdrawal of pressure in walking constitutes one of the best forms of massage. In addition, active use of the stump restores the conditions necessary for normal functioning of the circulation. It is certain that with this method of treatment the edema quickly disappears, the circulation becomes normal, and wounds and sluggish sinuses quickly take on a healthy appearance and heal rapidly.

VI.
Front view of thigh peg leg for long stump. Note suspender.

VII.
Same as Fig. VI, rear view. The cast has been varnished with shellac.

Special measures must be taken to protect the wounds in certain cases, particularly thigh amputations where the conical shape of the socket tends to crowd the soft parts up from the end of the bone and thus produce possible separation of the flaps. This accident can always be prevented by the application of traction and has never happened in the writer's experience. Broad adhesive straps with tapes are applied to the soft parts of the stump and the tapes passed down through the open end of the socket and buckled tightly to the lower portion of the apparatus in such position as to exert downward pull on the parts about the wound and protect it. These traction strips serve also to fix the leg to the stump and may be used in lieu of other form of suspenders.

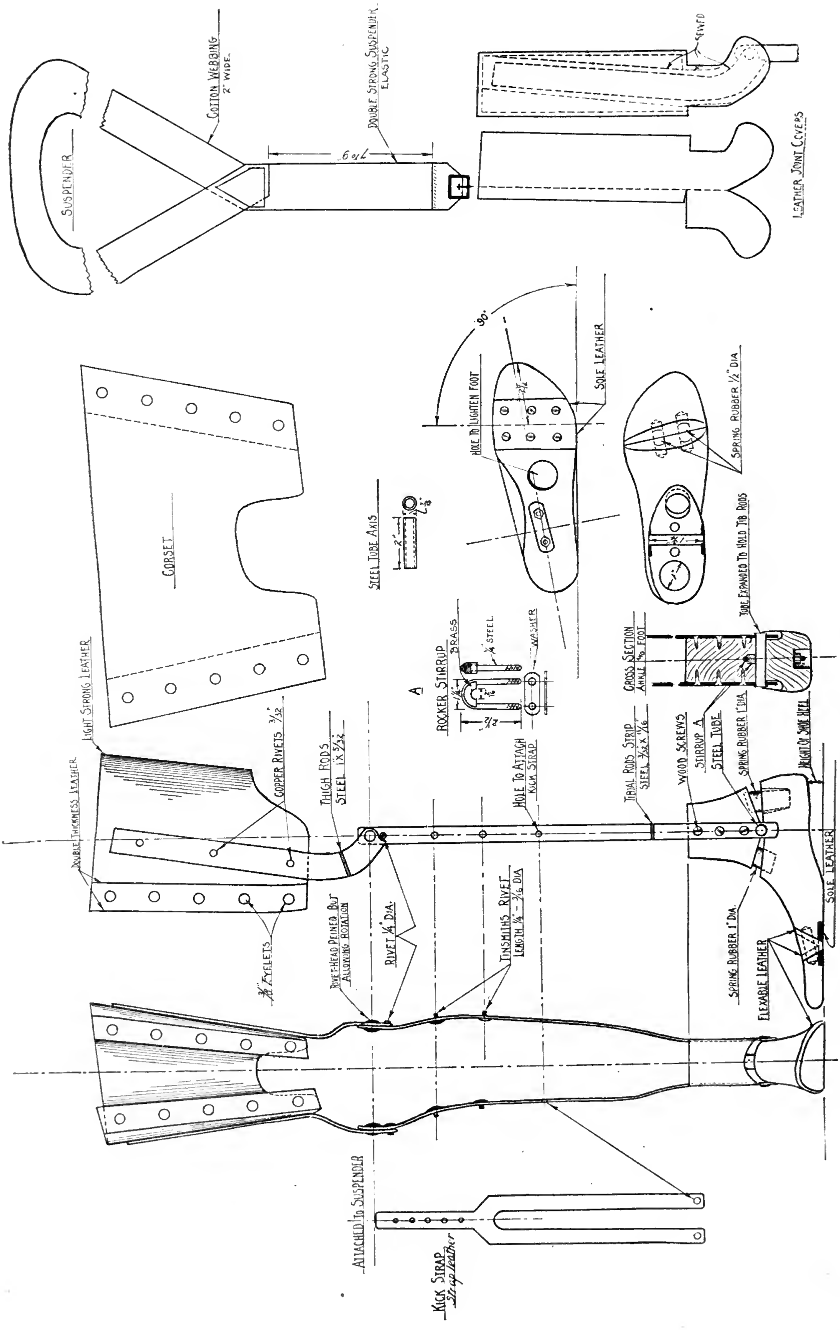
The presence of an open wound at the end of the stump is not a contraindication to early weight-bearing. Frequently during the war cases of amputation by the no-flap or guillotine method were fitted

VIII.

Peg leg for short thigh stump, showing the T side bar and pelvic band. A suspender is also used, as shown in Fig. VI.

with temporary legs during a fairly early stage of their convalescence. They were able to walk without pain and it was noted that their wounds healed more rapidly with this method of treatment than without. Traction was always provided in such cases.

Improvement has particularly been noted following weight-bearing in old infected amputation stumps with localized osteomyelitis and sinuses. Such cases ordinarily drag along many months and are often subjected to secondary operations before active use of the stump is allowed. Weight-bearing after the acute infection has subsided hastens the separation and discharge of sequestra, improves the circulation of the part, and favorably influences the course of the disease in the majority of such cases. Backing up of the discharge and abscess formation occasionally compel the temporary abandonment of the method, but it should be resumed as soon as the condition of the wound permits it.



IX. Diagram showing construction of skeleton leg for below-knee amputation.

X.

Below-knee leg. The frame is fitted and the side bars bent to conform to the shape of the stump.

2. Effect on the stump. In order to understand the effect on the stump of treatment by early weight-bearing, it is first necessary to consider the changes that should normally take place in it, following amputation. The operation deprives the larger part of the muscles in the sectioned limb of their insertion. Suture across the end of the bone of the groups antagonistic to each other is useful in preventing retraction, but will only preserve function in the relatively few muscles that originate above the proximal joint. The remainder no longer have work to perform and therefore atrophy, with resulting decrease in the stump diameter. In general, the longer the stump the greater the amount of atrophy, because the muscles arising from

XI.
Below-knee leg. The stump is covered with stockinette and the end protected with a pasteboard cuff. Traction is maintained on the stockinette.

the next higher bone segment are usually inserted in the stump close to the articulation. Another factor in producing stump shrinkage is the pressure of the socket of the artificial limb against the soft parts. This causes atrophy of the subcutaneous and intramuscular fat tissue and very considerable change in size. A stump that has been used actively for several years is often smaller by half than the normal limb.

From this it may be seen that stump shrinkage is entirely normal, that it is in part physiologic and in part due to weight-bearing. From the standpoint of function it is greatly desirable because the artificial limb can obtain a much better grip on an atrophied than a fat stump, with resulting increase in stability and leverage power.

Normal stump shrinkage is interfered with by the usual methods of treatment or, rather, lack of treatment. When a patient is allowed about on crutches without apparatus fitted to utilize the stump, the dependent position of the latter greatly favors an increase of the venous congestion and circulatory stasis produced by the operation. Instead of shrinkage in size there is increase in size on account of edema. Only active use can produce complete disappearance of the

XII.
Below-knee leg. Plaster is applied, covering the stump from its end to the middle of the patella.

swelling and the longer it persists the more difficult it is to bring about restoration of the normal circulation. With time there is absorption of some of the exudate, with increase in the amount of fibrous tissue. But the stump still remains large because, not serving any other useful purpose, Nature utilizes it as a convenient storehouse for fat just as she does any other inactive part of the body.

In such a stump nothing will produce shrinkage but active weight-bearing in an artificial limb. Tight bandaging or the use of laced leather "shrinkers," to be obtained of artificial limb makers, will help but will not furnish a solution. Furthermore, shrinkage will occur only in so far as the socket of the artificial limb remains tight enough to cause firm, even compression of the stump. This inevitably entails the changing of the socket two or three times during the process of evolution. On the other hand, this shrinkage does not go on indefinitely and, sooner or later, the length of time depending upon how soon weight-bearing is begun, the moment arrives when further decrease in size does not occur and the stump has reached the stage of complete evolution.

It is customary in present practice to wait three to six months after the amputation before beginning weight-bearing. The permanent type of limb is then fitted without any preliminary treatment to prepare the stump for its use. The stump under such conditions is fat, boggy and sensitive; the muscles which should activate it are atrophied and powerless, and important limitation of joint motion is commonly present. On the other hand, the leg used is relatively heavy and difficult to control. Close fit, freedom from pain, muscular strength, good coördination, and full range of joint motion are essential to its proper use. Learning to walk with an articulated limb is not easy at best; under the above conditions it becomes almost impossible.

In England and France during the first two years of the war it was impossible to supply artificial limbs in quantity sufficient to meet the demand. The great majority of the amputation patients had to wait many months before receiving them. During this period they went about on crutches without treatment, as it was before the possibility of using simpler forms of apparatus had been recognized. The condition of these men was lamentable indeed when they were finally examined for the fitting of their artificial limbs. The vast majority presented fat, congested stumps with powerless muscles and serious joint contractures. Practically all of them had to go back to the hospital for long periods of treatment before the limbs could be fitted. Many had to undergo serious operation for the correction of joint deformity. All made very slow progress and many never succeeded in learning to walk.

That such cases are very frequent in the surgery of peace, where the surgical supervision of the patient so commonly ends when wound healing has been obtained, is borne out by the cases seen by the writer in hospital and private practice. The application of some temporary apparatus such as described later, which permits weight-bearing soon after the amputation, hastens stump shrinkage, prevents congestion and edema, maintains tone and strength in the muscles which control the stump, and by normal use of the joints prevents limitation of motion.

II. *Economic.* The economic factor is of no small importance. Early weight-bearing reduces the period of convalescence by at least one-half. Convalescence ends when maximum functional restoration has been obtained. In the case of amputations of the lower limb this is represented not by the moment when the patient has been fitted with his permanent artificial limb, but when the stump has reached the

XIII.
Below-knee leg. The skeleton leg is applied, the side bars being covered with plaster and incorporated in the cast.

XIV.
The cast is finished and the upper margin of the socket is being marked out, in preparation for trimming.

stage of complete evolution and no further improvement in walking can be expected. By the methods commonly followed this is usually nine to twelve months, often longer. By the use of early weight-bearing it may be reduced to three to six months, seldom longer. Not only this, but the functional end result is better. When one considers the thousands of amputations performed in this country annually and multiplies this by the number of months of productive labor lost by old methods of treatment, figures quite fantastic in their economic importance are obtained.

Another advantage growing out of the use of the principle of early weight-bearing is more concrete, because it touches the pocketbook of the patient himself. The provisional apparatus used is very cheap. Change of socket, in order to keep pace with stump shrinkage, may be made at small expense. When maximum shrinkage has been obtained, the permanent limb is fitted and no further alteration is required.

On the other hand, when weight-bearing is only begun with the fitting of the permanent leg, stump shrinkage very quickly makes the socket too large for use. The only satisfactory method of altering a wooden socket is to make a new one. As this is a highly skilled operation it is also very costly, and as it must be repeated once or twice before the evolution of the stump is complete, this represents in its totality an expense that is usually but ill afforded.

III. *Psychologic.* Following the loss of a limb there is always a period of profound mental depression. The reaction to this usually takes one of two forms. Either the patient resigns himself to a life of invalidism and helplessness or he tries vigorously to resume his normal activities, fixing his hopes upon eventually becoming independent. The first means drifting, and if the pension is small may end in mendicancy. The second means maximum functional restoration, normal life, and economic freedom. The prolonged period of idleness, coupled with the consciousness of conspicuous deformity resulting from lack of treatment and the use of crutches, seriously favors the former, while early weight-bearing, even with a peg leg, by answering in a practical manner the question, "How am I going to walk?" gives a great impetus in the direction of normalcy.

Froelich of Nancy and Spitzy of Vienna share the credit of having been the first to apply the principle of early weight-bearing to the treatment of amputation cases. They used very simple forms of peg legs with plaster-of-Paris sockets. After them Martin at La Panne adopted the idea. He quickly saw its value and at the Ambulance

XV.
Below-knee leg. The leg finished, trimmed, and ready to wear.

XVI.
Temporary plaster peg leg for hip dis-articulation.

de l'Ocean, extended its applications to all cases as routine. The French and English Medical Departments were by this time beginning to understand that the treatment of the amputation cases constituted a problem special to itself. After seeing the results of delayed weight-bearing it required but a little time for them to see the advantages of the new method. Special amputation centers were formed at which the cases were concentrated and provisional apparatus supplied. One and all adopted the principle of early weight-bearing, only the types of apparatus used differed. Difficulty was encountered in making the plaster-of-Paris sockets rapidly enough to take care of all the cases. Certain countries (Canada and Germany), therefore, developed appar-

XVII.
Mesial aspect of peg leg for hip disarticulation.

XVIII.
Syme amputation and temporary peg leg.

XIX.
Syme amputation. Patient using end weight-bearing in his peg leg.

atus capable of being constructed in quantity, in different sizes, so that the stump might be fitted as a shoe is fitted to the foot. These served a good purpose, but never met all the indications in the way the individually fitted plaster peg leg did.

In the American Expeditionary Force the plaster-of-Paris socket was used as a routine, but the apparatus incorporated into it was quite special and was developed only after a good deal of experiment. It was found possible to train men to make the plaster sockets under the supervision of a trained leg fitter, and nearly fifteen per cent. of the two thousand amputation cases involving the lower limb sent home from overseas were fitted with this type of apparatus before they left. The large number of the unfitted cases is explained by the fact that they were either bed cases, on account of complicating injuries, or stayed too short a time at the special centers to be fitted. It was recognized as useless to supply provisional legs unless the men could be kept a sufficient time to train them in their use.

In private and hospital practice for the last two years the writer has applied the principle of early weight-bearing in the treatment of all cases of amputation seen by him. The results have been even more gratifying than in the Army because individual attention can be given and it is less difficult to get the patient's coöperation and arouse his enthusiasm.

For thigh cases the simple peg leg made from a wooden crutch frame with plaster socket has been found best to meet the indications. It is extremely light and there is no difficult knee control to be learned, both advantages of great importance when the weak and sensitive condition of the stump at this early period after operation is considered. A knee-joint and foot put weight at a distance from the stump and this position multiplies in direct ratio to the length of the lever the force necessary to move it. On the other hand, most patients object to a peg leg for cosmetic reasons. It is necessary thoroughly to convince them of the benefit to be derived from its use before their coöperation can be obtained.

For below-the-knee amputations the regular Army model with articulated foot has been used. The presence of the foot does not complicate early weight-bearing in these cases as it does with thigh amputations. Only an ankle articulation is involved and the motion of this is blocked in such a manner that the presence of the foot really increases the stability of the leg. Added to this is the great advantage that the patient's deformity is completely masked by the apparatus. The patient walks with scarcely any limp and functionally is quickly able to do almost as much as when fitted with his permanent limb. The skeletal leg can be quickly made by any artificial leg maker at a cost of about fifteen dollars. The only measurements required are a tracing of the outline of the stump and thigh with the level of the knee-joint indicated, the length of the sound leg (from the knee to the sole), and the size of the shoe. In addition two circumferences of the thigh, above the knee and near the perineum, should be given.

METHOD OF MAKING THE PEG LEG FOR THIGH AMPUTATIONS.

A frame is first prepared by sawing off an ordinary wooden crutch at a height corresponding to the length of the leg from slightly below the perineum. The handle is removed and the cut ends of the crutch frame tapered down with a knife.

The patient may either lie on a table or stand. The latter position

XX.

Temporary peg legs used at first for below-knee amputations in the A. E. F.

is slightly more convenient for the surgeon. The stump is first covered with tubular stockinette, the upper end of which is pinned to the clothing and the lower end left long enough to hang below the stump. An assistant holds this end and makes downward traction throughout the operation so as to compress the edematous soft parts about the end of the stump and give it a conical shape. A strip of cardboard six inches wide and long enough to encircle the thigh is next applied to the end of the stump in the form of an overhanging cuff and fastened with adhesive strips. This serves as a form on which the lower end of the socket can be made and prevents pressure against the wound and surrounding tissues when weight is borne. Plaster bandages are then applied as in making an ordinary cast, the plaster being rubbed in well. Three to four bandages usually suffice. Special attention should be given to moulding the plaster about the ischial tuberosity, perineum, and gluteal fold. Care should also be taken that the stump is not abducted while waiting for the plaster to harden, otherwise space will be found to exist between the sockets and the trochanter when weight is borne.

The wooden crutch frame is now applied, the upper ends of the uprights being first covered with a few turns of plaster bandage so that they will adhere to the socket. The frame is held by an assistant, and pains must be taken to see that it points in the axis of the limb and that the side pieces lie at the center of the mesial and lateral aspects of the socket. The uprights may be prevented from springing into the socket and indenting it by first separating them to the desired width and holding them in this position by forcing a roller bandage into the fork of the crutch. The frame is now fixed to the socket by applying one or two more plaster bandages in a circular manner, a few turns being taken also around the wooden uprights at the bottom of the socket.

When the plaster has set, the line of the top of the socket is marked out. It extends in front from the top of the great trochanter obliquely downward to the perineum where it is notched out to avoid the descending ramus of the pubis which is always sensitive to pressure. It then ascends obliquely under the ischial tuberosity outward to the starting point at the trochanter. This line corresponds exactly in shape and angle to the ring of the well-known Thomas leg splint. The leg is now removed from the stump and the stockinette and cardboard pulled out from the inside of the socket. The top of the socket is trimmed with a sharp knife along the line previously marked and the cut edge of the plaster smoothed over by rubbing into it a little plaster paste.

The leg is now set aside to dry and later finished up by reinserting the wooden crutch handle between the wooden uprights below the socket and painting the latter with shellac to make it more durable. It is fitted for length and the end sawed off so that when weight is borne the leg is one-half inch shorter than the normal leg. A rubber tip is applied to the end.

The stump is covered with a woolen stump sock when the leg is worn, and this gives all the padding necessary. When the leg is put on, the end of the sock is seized from underneath through the open lower end of the socket and strong downward pull made as the stump is inserted. This secures relaxation of the soft parts about the wound and protects the latter from tension when weight is borne. If traction strips are used an opening is made in the end of the sock through which the tapes are passed and these are secured by buckles to the cross piece in the frame.

Suspension of the leg from the body is obtained by means of a two-inch webbing band with a piece of elastic inserted in the middle passing

beneath the cross piece in the leg and over the opposite shoulder, the two ends being buckled together in front.

If the amputation is above the middle third of the thigh the socket tends to slip off the stump when the leg is slightly abducted and causes instability. This may be largely prevented by riveting a "T" shaped iron extension to the top of the socket on its lateral surface and securing this to the pelvis by means of a webbing belt. The vertical limb of the iron should be jointed at the level of the top of the great trochanter in order to permit flexion and extension and should extend upward to just below the level of the anterior superior spine of the ilium. The horizontal limb of the iron is about five inches long and is curved to conform to the shape of the pelvis. It is this portion to which the belt is attached by rivets.

METHOD OF MAKING PROVISIONAL LEG FOR BELOW-THE-KNEE AMPUTATION.

As previously stated, the skeleton leg for this type of amputation is made by an artificial limb maker. It can usually be obained a week after placing the order. It is then fitted to the patient's stump and thigh to determine if the length is correct and the iron side bars properly bent to conform to the outline of the limb. The side pieces are sufficiently malleable so that changes can be made if necessary without special tools or skill.

If it is not possible to secure a provisional leg of the type described, one may substitute a simple form of peg leg. In this case malleable strap iron is cut to the proper length and bent to the shape of the stump. Two pieces, one on the lateral and one on the mesial side of the stump, are used as uprights, and after the socket has been made, a wooden peg is fitted between their protruding lower ends and fastened with screws.

The application of the plaster is most easily made with the patient seated. The stump is covered with the stockinette and if the end is bulbous, traction must be made as in the thigh cases by an assistant to compress and pull down the soft parts. The end of the stump is likewise protected from the direct pressure of the socket by a circular cuff of cardboard. Pressure of the socket on the external popliteal nerve lying on the head of the fibula is apt to be painful and may be prevented by fixing a small felt pad in this region with a strip of adhesive plaster.

With the knee extended, two to three plaster bandages are now applied covering the stump in a circular manner and extending from the middle of the patella to the bottom of the pasteboard cuff. The plaster should be carefully moulded about the upper end of the tibia as most of the

XXI.
Temporary peg legs with lock knee joint, permitting flexion when sitting.

weight is transmitted to the socket here. When the plaster has hardened, the skeleton leg is applied and the upper end held by lacing the thigh corset. The lower end is held by an assistant who also steadies the extremity of the stump by holding the loose end of the stockinette. Care must be taken that the iron frame is in the axis of the stump, that the joints for the knee are centered on a line with the middle of the patella, and that the tip of the wooden foot is in line with the center of the patella and the anterior superior spine of the ilium. If any space exists between the side bars and the previously applied portion of the socket it should be filled with folded pieces of plaster bandage, so that the irons are everywhere in contact with the plaster surface. Two or three plaster bandages are now applied, solidly fixing the frame in place.

The line of the top of the socket is next marked out with a skin pencil. This line runs in front from the lateral surface of the joint line downward and under the lower border of the patella, then upward to the

XXII.
Group of soldier patients overseas, equipped with different types of legs.

joint line on the mesial aspect of the knee. Behind the knee it curves down and then goes up to the starting point, forming a hollow in the popliteal space, so that the top of the socket will not cut into the hamstring muscles when the knee is flexed.

When the plaster has set, the leg is removed from the stump, the upper edge of the socket trimmed with a sharp knife, and the cut edge smoothed over with plaster paste. The apparatus is then set aside to dry. Occasionally, when the iron frame has not been properly fitted, there is a tendency of the uprights to spring apart and deform the socket before the plaster has solidified. This may be avoided by winding bandage about the uprights just above their point of attachment to the wooden ankle piece.

During this period one must take the precaution to keep the stump tightly bandaged with elastic material, otherwise swelling may occur, and it would be difficult to get the leg on again. In this connection one should remember that it is much easier to pull the stump into the socket from below by reaching up and grasping the end of the sock, rather than push it in from above. The latter crowds the soft parts up from the extremity and this not only enlarges the stump but causes tension over the end of the bone and makes walking painful.

If the extremity of the stump is particularly bulbous it may prove impossible to withdraw it from the socket after making the leg. In that case one may split the plaster posteriorly and spring it apart until

sufficient room is obtained. The same procedure is used in inserting the stump, and the socket is then drawn together with buckle straps or bandage. With weight-bearing the terminal swelling quickly subsides and then a new socket may be made which does not require splitting.

Fixation of the leg to the body is secured by means of the leather corset which laces about the thigh. Other suspension is usually unnecessary. When required, a webbing band two inches wide is used, arranged in the form of a loop passing over the opposite shoulder and under the axilla of the affected side. The ends of the loop are fastened together in front near the groin and from their junction an elastic webbing band of the same width descends to be fastened to the front of the thigh corset or to the leg itself below the knee. If traction is required to protect the wound it may be obtained in the same way as with the thigh peg leg.

METHOD OF MAKING PROVISIONAL APPARATUS FOR SPECIAL TYPES OF AMPUTATION.

Disarticulation of the Hip.

The crutch peg leg is used with a plaster-of-paris socket shaped like the half of a basin. It encloses half of the pelvis and extends slightly above the anterior superior spine. It is moulded accurately to the bony contour and may be padded with felt. In it the patient sits as in a deep Mexican saddle.

The wooden crutch is cut so that one side piece is about three inches longer than the other. The long upright is fixed to the lateral surface of the socket while the short piece extends to the under surface in the region of the perineum. Fixation is secured by means of plaster bandages as with the apparatus previously described.

Suspension is obtained by means of a webbing strap passing under the plaster socket, buckling in front. A webbing belt fixes the socket to the pelvis and prevents lateral displacement.

Patients with this type of amputation learn to walk very well with a provisional peg leg. Not only is there comfort but good stability and power. Sitting is difficult but can be managed, and progress is so rapid that it is scarcely worth while to provide the necessary joints and unlocking device to allow flexion in sitting.

Syme Amputation.

A simple form of peg leg has been used in these cases and has proved of great value in developing the all-essential end weight-bearing ability

of the stump. A good Syme is so satisfactory that no pains should be spared in achieving this result.

A plaster cast is applied enclosing the stump to below the knee. Light iron side pieces are fixed in the plaster on the mesial and lateral surfaces, the ends projecting two inches below the bottom of the cast. An oval-shaped window is then cut out of the front of the plaster to allow the withdrawal of the stump with its enlarged distal portion.

After the cast has dried the projecting irons are drilled for the passage of screws, and a wooden block of the necessary length is fitted. Fixation of the cast to the stump is obtained by replacing in its opening the plaster door previously removed and fastening it with buckle straps or bandage.

The patient walks in this plaster peg at first with the weight distributed between the usual bearing surfaces and the end of the stump. Later, as sensitiveness disappears, felt pads are inserted at the bottom of the socket, and their thickness is gradually increased until the entire weight is borne on the end of the stump. The top portion of the socket may then be removed and the patient walks in this small plaster boot until the permanent type of limb is fitted.

Summary.

1. Experience gained during the war in the treatment of patients with amputations of the lower limb has shown that it is possible to get such patients out of bed without crutches and actively bearing weight in peg legs or simple forms of artificial limbs at a period two to three weeks after amputation.

2. Early weight-bearing is of great advantage to the patient because (*a*) It promotes healing of the wound by improving the circulation, and in cases with terminal localized osteomyelitis favors the separation and spontaneous discharge of sequestra. (*b*) It hastens stump shrinkage and prevents muscle atrophy and the development of joint contractures. (*c*) It favorably influences the patient's morale. (*d*) It greatly shortens the period until the permanent artificial limb can be fitted and reduces the need of frequent alterations in the socket, and thereby much expense to the patient.

3. Provisional apparatus to secure early weight-bearing may be made to best advantage of simple materials, in the use of which the surgeon is already skilled.

4. With understanding of the advantages of early weight-bearing in the treatment of amputations of the lower limb, and of the little difficulty involved in its application, the method should be universally applied.

REPORT OF THE ORTHOPÆDIC EXAMINATION OF 1393 FRESHMEN AT YALE UNIVERSITY.

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In the past two years as Orthopædic Surgeon to the Department of University Health of Yale University, I have been privileged to examine, in the two entering classes of 1923 and 1924, a total of 1393 men.

A university such as Yale draws a selected group of men, who come from families where no little attention is paid to the physical welfare of the children. Furthermore, in the case of the larger number of men, considerable interest has been taken in their athletic development during the years of their preparatory schooling. These young men, therefore, certainly show a physical development as high or probably higher than any other group selected at random. The purpose of this survey has been to detect the possible correctible deformities, any defects in posture or body carriage, or any evidence of faulty development at a period when there is still time to correct them before the developmental period of the individual is past.

While the object of this examination has been to find those individuals who have some body defect and to undertake its correction, it must be kept in mind that at the same time this survey, including as it does all the students of the entering class, offers an excellent opportunity to

determine, from a group of so-called normal physical men, the percentage which have some postural or bodily mechanical defect. The examination of such a group of men affords us insight into the incidence of the minor as well as of the major body defects.

This report is a study of the postural or the body mechanical condition of a group of men in transit from preparatory schools to college life. The majority have had considerable attention given to their athletic development, but few, except those entering from military schools or those recently discharged from the army, have had their attention drawn to the mechanical set-up of their body. Instead, almost all have been under the instruction and care of individuals whose object was directed entirely to the development of muscular strength or athletic skill, and not to the correction of the abnormalities in the postural set-up or the mechanical relationship of the several component body parts.

It seems desirable to urge the correction of such faulty body attitude as round shoulders, round and hollow backs, lateral curvatures of the spine, flat chest, prominent abdomen, and weak feet. Such corrective work among college men, when directed either toward improving existing mechanical faults of the body or toward preventing those likely to occur, aside from improving the physical appearance of the man, should improve the efficiency and general health of the individual throughout life.

The orthopædic examinations were conducted in conjunction with the mensuration examinations given to the students by the Director of the Gymnasium. During the first year, individuals needing special work were discussed with him and placed under his supervision to carry out the necessary corrective exercises, but for the men of the class of 1924 the Director of the Gymnasium has designated a man who gives his entire time to corrective work. Those who needed such work were formed into small classes, varying from 10 to 12, and in this way we have been able to give them intensive training leading to the correction of their individual body defect—a marked improvement over the previous general gymnastic instruction.

As may be seen from the record inserted below, the age of the individual was obtained; he was questioned about bone and joint injuries, foot trouble, backache, his past athletic work, and his future athletic intentions. The routine orthopædic examination follows:

Name .... Class .... Age	Date ....
Athletics in preparatory school	In Yale ....
Describe any bone or joint injury	any backache or back injury ....
Any trouble with your feet	any muscle, tendon, ligament or nerve injury ....

Fill in Above. Do Not Write Below This Line. Use Back of Card If Necessary.

Abnormalities of head...............	Neck, chest: normal, flat, prominent, funnel, pigeon ....
SPINE. Deviation, none, right, left ...	Rib margin: level, flat, flaring.......
Antero-posterior curvature	Right, left, side, forward; right, left, side, back ....
Kyphosis: 0, 1, 2, 3, 4; Lordosis: 0, 1, 2, 3, 4.	ABDOMEN: scaphoid, flat, prominent, protuberant ....
Kypho-lordosis: 0, 1, 2, 3, 4; Flat-back, 0, 1, 2, 3, 4	Upper extremity ....
Scoliosis	None ....

Postural: left, right, distance from perpendicular at .... spinous process ....

Left, right, shoulder, high: right, left, shoulder, back .... Lower extremity ....

Rotation, right, left ....

Structural: distance from perpendicular to left at ....

Spinous process: to right at .. sp. process .. Length .. right leg left ..

Left, right, shoulder, high: right left, shoulder, back .... FOOT ....

Rotation right ...... left	Longitudinal arch: high, medium, low, absent ....
Pelvis level, tilted down on left, right ...	degrees .... Transverse arch, average, low, absent ....
Neck forward .... degrees from perpendicular	Pronation: 0, 1, 2, 3, 4 ....
Round shoulders: 0, 1, 2, 3, 4.........	Flexibility; normal, fair, poor, absent.
Motion of spine: forward bend	backbend...Dorsiflexion .. degrees ..
rightside bend, left	Abnormalities of foot ....
Muscle spasm .. Paralysis back	Toes: hammer, hallux, valgus, absent.
Sacro-iliac joint	Strength in pounds ....
	................right adduction left...
....	...................right abduction left
....	...................dorsal flexion plantar.
....	...................flexor long hallux
TREATMENT	Foot tracing ....
	Photograph ....
	Summary ....

In order to record the condition of the individual at the time of the examination, photographs were taken. This photographic record, taken at the beginning and repeated at the end of the school year, shows the progress during the period of corrective work. In recording the class of 1923, a profile view was taken, showing the man in his natural standing position and in his best standing position. At the end of the

year it was found that many of the men who were given individual work could hold naturally and without constraint a poise the equal of their best possible standing position in the fall. The records of the class of 1924 were taken, one in profile and one posterior view. These photographs have been difficult to take in exact profile and have been difficult to repeat exactly, due to the swaying and shifting of the student after he has been posed. With the photograph and the record, the mechanics of the trunk were then studied with reference to kyphosis, lordosis, and flat back, conditions that are grouped in the tables under the topic of increased antero-posterior curvature, postural and structural scoliosis, flat chest and prominent abdomen. The grouping of kyphosis, lordosis, and kypho-lordosis has presented a considerable difficulty, since the presence of either kyphosis or lordosis is usually associated with the other. Consequently, the more marked defect is listed. The tilting of the pelvis was recorded in cases where present, and the length of the legs was taken to note the relation to scoliosis when it existed.

In the foot the varying heights of the longitudinal arch are recorded. Pronation is recorded in groups according to severity. Pain in the foot was investigated and was discovered to have been present in the past in some cases, but at the time of examination it was present in only a few; and in all cases, both past and present, in less than 10%. The flexibility of the foot was noted, the dorsiflexion of the foot, and the presence or absence of a short heel cord was recorded.

The shoulders and spinal curves were recorded as normal or grouped, according to the severity of their abnormality, as falling in the first, second, third, or fourth group, these groups being in sufficient number to record the seriousness of the defect.

The grouping of round shoulders, increase in the antero-posterior curvature of the spine, pronation of the feet, and height of the longitudinal arch of the foot, has been arbitrarily classified. While it would be desirable to classify each case, mathematically the slight variation of the several individuals in the group do not make it worth while at present.

These statistics are derived from the tabulation of the examination records of 1393 men, giving a group large enough so that it is felt that their presentation is worth while. In some of the smaller divisions, as backache and scoliosis with inequalities of the feet, it is not thought that there are enough cases from which conclusions can be drawn, and such tables are presented for what they may be worth. The results are tabulated as follows:

GENERAL TABLE.

	Percent
Bachache present	5.2
Backache absent	94.8
Spinal deviation—none	80.3
Spinal deviation—to the right	9.8
Spinal deviation—to the left	9.9
Round Shoulders—none	3.5
Round shoulders—first group	27.1
Round shoulders—second group	43.0
Round shoulders—third group	24.3
Round shoulders—fourth group	2.1
Normal antero-posterior curvature	44.1
Increased antero-posterior curvature, first group	19.0
Increased antero-posterior curvature, second group	24.7
Increased antero-posterior curvature, third group	10.6
Increased antero-posterior curvature, fourth group	1.6
Increased antero-posterior curvature, total	55.9
No lateral curvature	49.7
Postural scoliosis to the left	39.1
Postural scoliosis to the right	1.2
Structural scoliosis	10.0
Scoliosis, total	50.3
Scoliosis and increased antero-posterior curve combined	34.0
Normal spinal curvature	24.8
Chest normal	43.7
Chest flat	56.0
Pigeon breast	0.1
Funnel breast	0.2
Abdomen prominent	41.7
Abdomen, normal contour	58.3
Legs—equal length	85 4
Leg—right short	0.8
Leg—left short	13.8
Pelvis level	83.1
Pelvis—right side low	0.8
Pelvis—left side low	16.1
Foot trouble, past and present	7.2%
Pronation of feet .. none	17.9
Pronation of feet .. first group	42.3
Pronation of feet .. second group	29.5
Pronation of feet .. third group	9.8
Pronation of feet .. fourth group	0.5
Longitudinal arch high	5.6
Longitudinal arch medium	58.3
Longitudinal arch low	35.8
Longitudinal arch gone	0.3
Dorsiflexion of foot .. right angle or less	3.0
Dorsiflexion of foot .. 5°	13.9
Dorsiflexion of foot .. 10°	62.3
Dorsiflexion of foot .. 15°	20.8
Short Tendo Achillis	3.0
Flexibility of foot, normal	90.0
Flexibility of foot, limited	10.0

YALE UNIVERSITY: DEPARTMENT OF HEALTH. Orthopædic examination.

The forward droop or rounding of the shoulders has been recorded separately from the curvature of the spine, because, while frequently occurring together in relatively equal degree, there are many cases in which the two are dissociated. The shoulder girdle does not follow the contour of the chest wall in a similar manner in all cases; in some, as kyphosis increases and the chest wall flattens, the shoulder seems to be carried straight forward, while in other cases the shoulder seems to follow around on the lateral and upper side of the chest wall; in the first instance, the posterior aspect of the scapula slopes directly backward, while in the second instance it will be found sloping laterally as well as posteriorly.

The deviation of the spinal column at the level of the seventh cervical vertebra to the right or left of a plumb-line passing over the cleft of the buttocks was recorded. Such deviation occurs in cases in which no scoliosis exists, though it is usually associated with it. It is of interest to note that approximately 20% showed a spinal deviation under the above definition, while about 50% showed some type of scoliosis.

The scoliosis, postural or structural, when present, was recorded at the level or levels where the curve was the greatest. The motions of the spine, in cases of scoliosis, as a rule, were very slightly limited in bending against the convexity of the curve. This may be due to the rather slight curvatures, and to the physical activity of the individual. In the more marked cases of increase in the antero-posterior curvature, a moderate amount of stiffening of the spine has been noted.

Chests varied from normal to the usual grades of flatness. It is found that a flat chest, while usually associated with an increase in the antero-posterior curvature of the spine, was occasionally found among those having an approximately normal spinal contour.

Abdomens among these students are usually full, some are scaphoid, and a few are beginning to protrude.

If one glances through the general table, he cannot fail to be impressed with the low percentage of normal students. But 3.5% had no rounding of the shoulders; but 44.1% have a normal antero-posterior curvature; but 49.7% have no scoliosis; while only 24.8% have a normal spinal contour. The chest is normal in 43.7% of cases, while in over half it is flattened to some extent. Of interest in the feet is the fact that but 7.2% have had foot trouble. Less than one-fifth of this group have no pronation of the feet. The height of the longitudinal arch is satisfactory in the majority of cases; in fact, in only .3% of the cases was the arch found to be gone. Dorsiflexion of the foot is limited to a right

angle or less in but 3% of the cases, while the flexibility of the foot is free in 90% of cases. In general, the defects are those of poor trunk posture, carrying of the head and neck too far forward, rounding of the shoulders, increase in the antero-posterior curvature and lateral curvature of the spine, flat chest, prominent abdomen, pronation of the feet, and, in some cases, relaxed ligaments and muscles of the feet.

A topical study of the more interesting subjects of the general table is of interest. If we consider the trunk first, we find that 5.2% gave a history of backache, of which 1.9% gave physical exertion as the exciting cause; .6% were associated with disease, while in 2.7% no cause is known for the existence of the complaint.

BACKACHE.

Thirty-one of these cases of backache gave as a cause of their backache exertion in either work or sport. In five cases we find that backache has been associated with rheumatism, cardiac deficiency, lumbago, or an old empyema scar. Thirty-six of these cases had backache, but could give no reason for it. They complained of discomfort in the back, of a tired feeling or of pain in the small of the back, or in the thoracic region. The total number of these cases of backache is seventy-two.

Dr. Brown (*Am. Jour. of Orth. Surg.*, Vol. xv, No. 11, pp. 774-787), in his report on the examination of Harvard freshmen, found that 15.1% complained of backache, and that these men were in the group bearing a notably poor posture. In the Yale examination, 5.2% complained of backache; and it is of interest to note that backache, among athletes or those accustomed to work (in which cases the injury could be traced), is found in the majority of cases among the half of the class who have a relatively good posture, while those individuals who could give no reason for backache were found to be classed more frequently in the half of the class having a relatively poorer posture.

Of the thirty-one cases in which backache has come on following exertion, strain or trauma, eight fall into the first group, fifteen in the second, five in the third, and one in the fourth group of round shoulders: the shoulders and antero-posterior curvature of the spine are normal in two, and nine cases, respectively, while ten cases fall into the first group, seven into the second group, three in the third group, and two in the fourth group of increase in the antero-posterior curvature of the spine; in twenty-three cases scoliosis is present, while in thirteen cases scoliosis and an increase in the antero-posterior curvature are combined. In this group of traumatic backache several have received the primary injury in football, others have either strained or sprained their backs

while working; in single cases the injury was from a fall, from diving, and from a machine shop accident in which the individual was struck by machinery. It is of interest to note in these cases of traumatic backache that while the discomfort is not severe, it is lasting; further, that in these cases the postures in general are fairly good. Note that the round shoulders and the increases in the antero-posterior curvature are in the milder groups mainly; the scoliosis, though present in a large number of cases, is usually of the postural type. One thing that may be worth noting is that these back injuries, at the time they were received, were treated rather lightly or not at all, and this may, in some cases, explain their continuation to the present time.

There are five cases associated with disease,—one of rheumatism, two of cardiac disease, one of lumbago, and one with Pott's disease. The postural changes in this group suggest little.

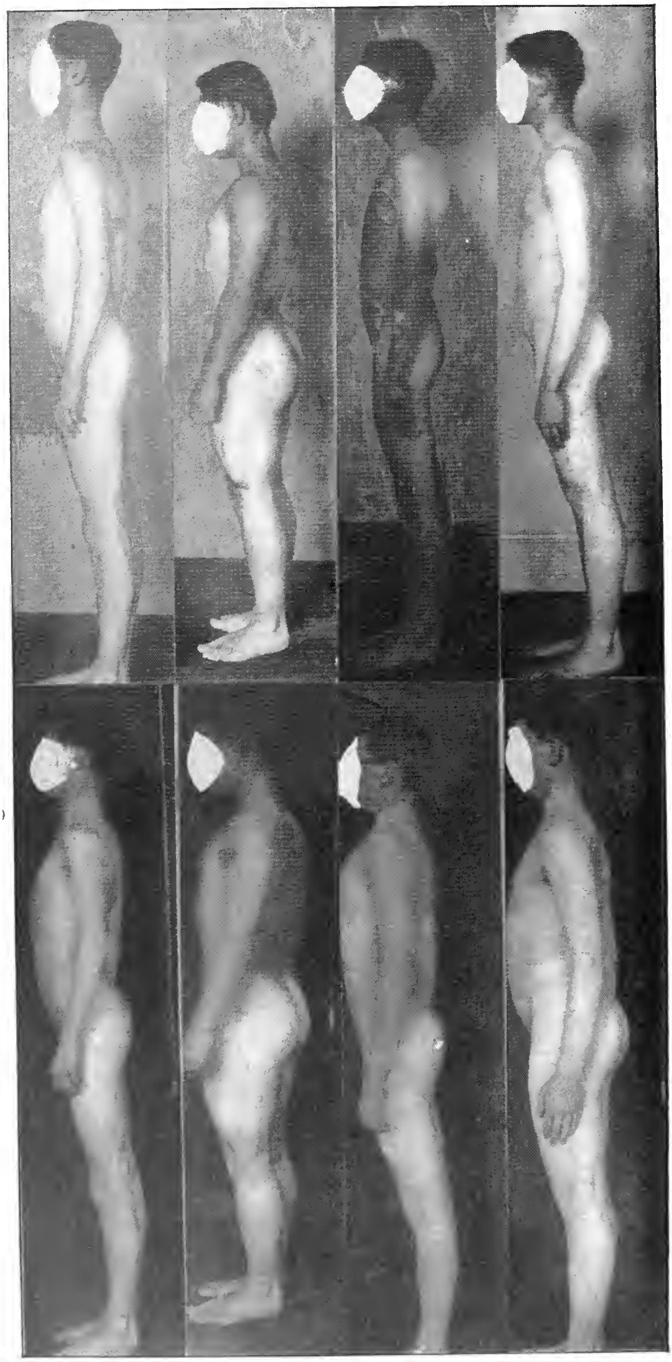
Of the cases in which no known cause is given for backache, there are thirty-six. Among these there is a deviation of the spinal column from the vertical in six cases. The first degree of round shoulders occurs in five cases, the second and the third in fourteen each, and the fourth degree in three cases. As regards the increase in the antero-posterior curvature of the spine, it may be said to be but moderately accentuated. Postural scoliosis occurs seventeen times and structural scoliosis five times. Twenty-five cases have flat chests and nineteen have prominent abdomens. The pelvis tilts in six cases, a short leg is present in three. Pronation of the feet is present in the first degree eighteen times, in the second degree eleven times, and in the third degree five times. In this group with unexplained backache, foot trouble had been complained of in the past in but three in the total of thirty-six cases.

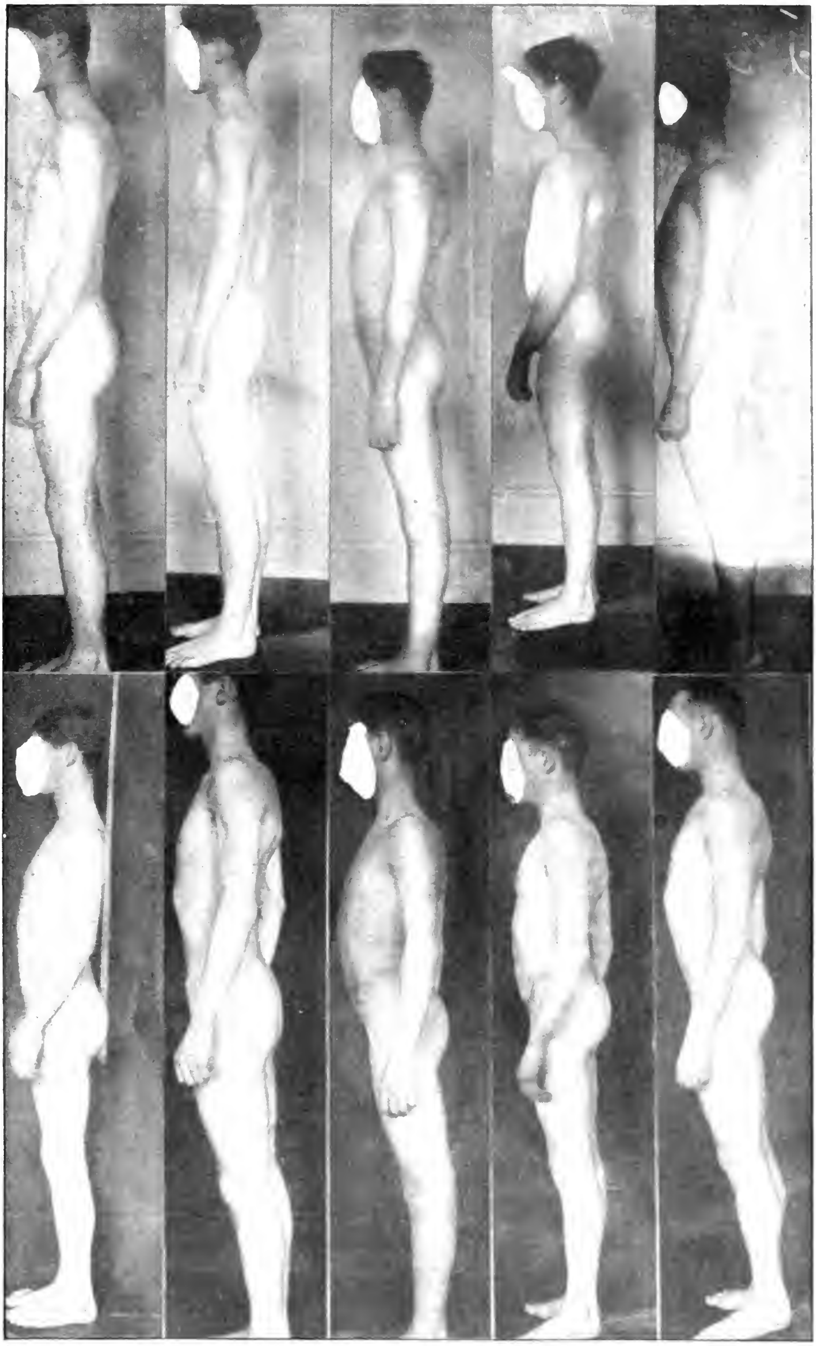
BACKACHE		Deviation of Spine	ROUND Shoulders Group					Increased Antero-posterior Curvature Group					Flat chest	Prominent Abdomen	Scoliosis		Pelvis tilted	Short leg	Pronation Group				
	5.2%		None	1	2	3	4	None	1	2	3	4			Postural	Structural			None	1	2	3	4
From work	1.9%	1.0	0.1	0.5	0.9	0.3	0.1	0.5	0.4	0.6	0.3	0.1	1.2	1.1	1.0	0.2	0.3	0.1	0.2	0.9	0.7	0.1	0.0
Associated with Disease	0.6%	0.1	0.1	0.1	0.2	0.2	0.0	0.2	0.2	0.1	0.0	0.1	0.4	0.4	0.3	0.1	0.2	0.1	0.1	0.3	0.1	0.1	0.0
No known cause	2.7%	0.5	0.1	0.4	1.0	1.0	0.2	0.8	0.6	0.5	0.4	0.4	1.6	1.1	1.4	0.3	0.8	0.3	0.2	1.4	0.8	0.3	0.0

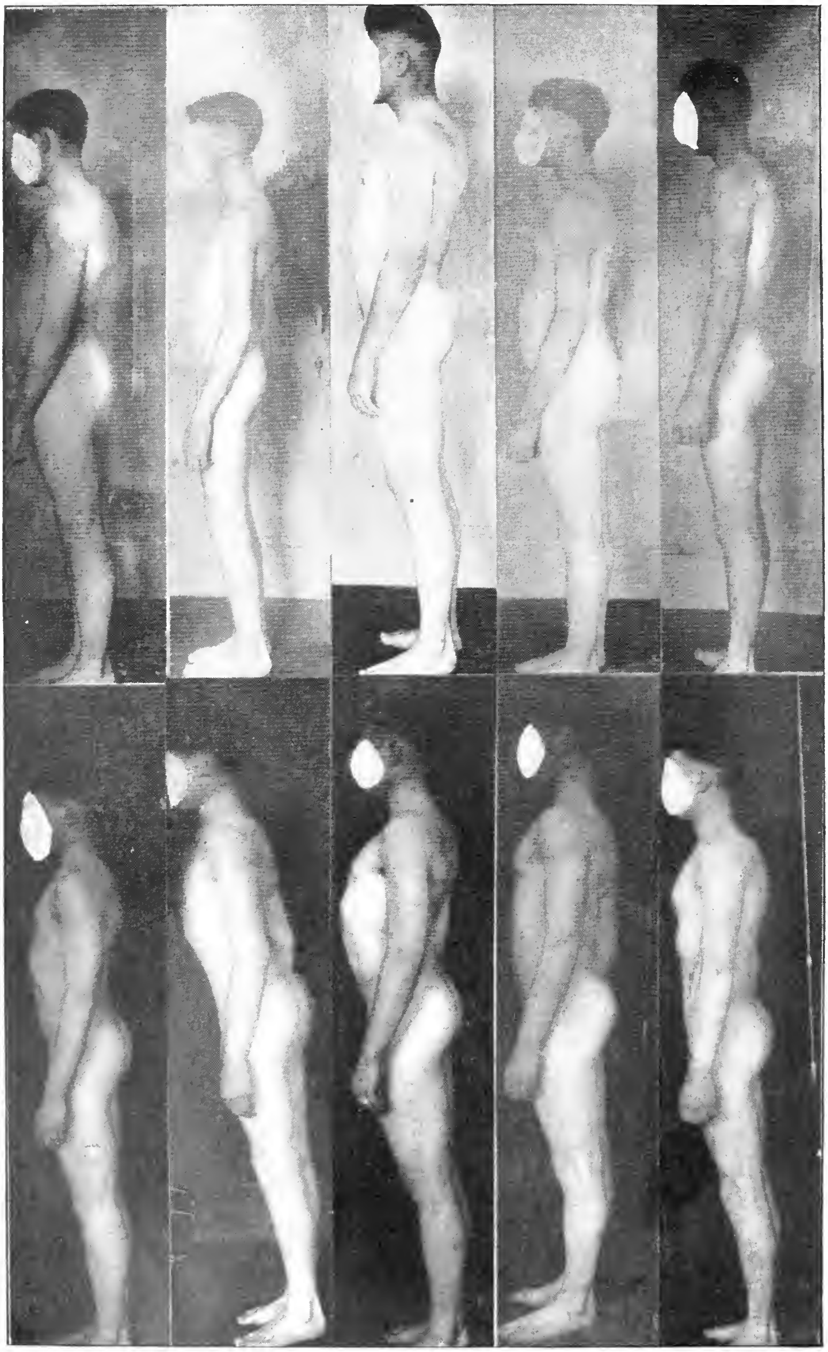
The following three plates show photographs of men taking correctional work.

The upper row shows the man in his natural standing position in the Fall; the lower row shows the man in his natural standing position in the Spring, following a course of correctional training.

In column the photographs are of the same man.







In the group of backaches, taken as a whole, it is to be noted that round shoulders of a mild degree occur in the group of traumatic backache and of a more marked degree in the backache of unexplainable origin. This same statement would hold true, to a slightly less degree, when applied to increase in the antero-posterior curvature of the spine. The flat chest of individual predominates. Scoliosis is present in but little less than one-half of the cases. Pronation of the feet is present usually in the milder degrees, though it is found that it occurs more commonly among those cases in which the backache is unexplained. Generalizing, we may say that the body posture or mechanics is not as good in the group of unexplained backaches as among those in which trauma is a factor.

ROUND SHOULDERS.

Round shoulders are found either with or without increase of the antero-posterior curvature of the spine. In 2.7% of the total cases normal shoulders occur with a normal antero-posterior curvature of the spine, while in 41.4%, in which the antero-posterior curvature of the spine is normal, the occurrence of round shoulders in varying degree is noted, being more common among the milder grades. In .8% of the cases in which the antero-posterior curvature of the spine was increased, the shoulders remained normal. In the cases in which both round shoulders and kyphosis occur, the round shoulders show a greater degree of severity, proportionately, than does the kyphosis. When compared with lateral curvature of the spine, round shoulders are not found in proportion to the type of severity of scoliosis, though both commonly occur together. The frequency of flatness of the chest parallels the rounding of the shoulders, as it also does the increased antero-posterior curvature of the spine, on which it seems the more dependent. The prominence of the abdomen increases proportionately with the severity of the round shoulders, though its presence is found in more true association with an accentuation of the antero-posterior spinal curvature, and a flattened chest.

As pointed out by Bradford (*Orth. Trans.*, Vol. x, p. 162), and by Hasebrook (*Zeitschr. f. orth. Chir.*, xii, p. 612), a shortening of the soft parts anteriorly, as well as a relaxation of the posterior muscles moving the shoulder girdle, is usually found.

Round Shoulders		Backache	Deviation spinal column	Increased Antero-Posterior Curvature					Scoliosis			Flat Chest		Prominent Abdomen		Pronation				
					Group												Group			
	%			None	1	2	3	4	Postural	Structural	None	Present	Absent	Present	Absent	None	1	2	3	4
None	3.5	0.3	0.4	2.7	0.4	0.2	0.1	0.1	1.0	0.3	2.2	0.7	2.8	0.8	2.7	0.8	1.5	0.9	0.3	0.0
Group 1	27.1	1.0	6.2	17.3	6.8	2.4	0.6	0.0	11.2	2.7	13.2	8.3	18.8	12.1	15.0	4.7	12.3	7.8	2.3	0.0
Group 2	43.0	2.1	8.0	20.3	8.5	12.3	1.8	0.1	18.4	2.9	21.7	22.0	21.0	18.0	25.0	7.4	18.7	13.2	3.5	0.2
Group 3	24.3	1.5	5.0	5.8	3.2	9.4	7.4	0.5	8.9	3.8	11.6	15.7	8.6	10.3	14.0	4.8	8.7	6.9	3.6	0.3
Group 4	2.1	0.3	0.1	0.0	0.1	0.4	0.7	0.9	0.8	0.3	1.0	1.9	0.2	0.5	1.6	0.2	0.6	0.9	0.3	0.1

ANTERO-POSTERIOR CURVE OF THE SPINE.

The present-day idea of posture or body mechanics seems to depend largely upon the conception of the normal antero-posterior curvature of the spine. If the spine has a normal forward curve in the cervical region, a normal backward curve in the dorsal region, and a normal forward curvature again in the lumbar region, we feel fairly certain that the individual is carrying his head at the proper angle, that his shoulders are carried back, his chest forward, and that his abdominal wall is flat. On the other hand, if the individual has a dorsal kyphosis of any degree, we usually find it associated with an increase in the other regional spinal curves, with the head carried forward, the chest flattened, and the abdomen prominent or protuberant, while the rounding or forward droop of the shoulders is increased.

In this series of cases, 44.1% of the cases have an approximately normal antero-posterior spinal contour; but of this number only 2.7% have normal shoulders, while 41.4% have round shoulders of varying degree, thus showing that a normal antero-posterior curvature is not necessarily accompanied by shoulders normally carried; a flat chest was found in 17.4% in association with a normal spinal curvature, while the abdomen was prominent in 11.8% of the cases, and backache was complained of in 1.6% of the cases in this group. Of the remaining cases, the majority fall into the moderately marked groups of increased spinal curvature. Only 1.6% fall into the poorest group associated with the more marked degree of round shoulder.

Increased antero-posterior Curvature 55.9%	Percentage of cases	Round Shoulders Group					Flat Chest		Prominent Abdomen		Backache	
		None	1	2	3	4	present	absent	present	absent	present	absent
Normal	44.1	2.7	17.3	20.3	3.8	0.0	17.4	26.7	11.8	32.3	1.5	42.6
Group 1	19.0	0.4	6.8	8.5	3.2	0.1	10.2	8.8	14.3	4.7	1.2	17.8
Group 2	24.7	0.2	2.4	12.3	9.4	0.4	13.4	11.3	10.3	14.4	1.2	23.5
Group 3	10.6	0.1	0.6	1.8	7.4	0.7	6.6	4.0	4.4	6.2	0.7	9.9
Group 4	1.6	0.1	0.0	0.1	0.5	0.9	1.0	0.6	0.9	0.7	0.6	1.0

SCOLIOSIS.

As regards scoliosis, 49.7% have no scoliosis, 1.2% have a right postural, and 39.1% a left postural scoliosis, while 10% have a structural scoliosis. Rounding of the shoulders is, of course, associated with scoliosis, both being evidence of body weakness; however, the presence of round shoulders in association with scoliosis does not occur in proportion to the type of scoliosis or its severity. It is to be noted that 31% have scoliosis, and increased antero-posterior curvature; that 24.8% have a normal spinal contour; that 24.9% have an increased antero-posterior curvature without scoliosis; that 19.3% have scoliosis alone.

Comparing the statistics given by Lovett (Lateral Curvature of the Spine—Blakiston, 1907), we find that of our cases of functional scoliosis 97% are to the left and 3% to the right, as against 90% and 10%, respectively, as cited by him. Luning and Schulthess (*Orthop. Chir.*, J. F. Lehmann, 1901) give the relationship of left functional scoliosis to the right as 5:1.

Estes (*Jour. A. M. A.*, Vol. 75, No. 21, p. 1411), in seven yearly examinations of the students at Lehigh, in five years of which the examination was done by the Physical Director of the Gymnasium, and in the two later years being done by himself, finds the percentage of scoliosis to vary from 9.5 to 43.6% in the seven different classes. This compares with 50.3% of the class here.

The relationship of the types of scoliosis as found by Estes were: Left total, 69.8%; right total, 12.6%; and structural, 17.5%. It is to be regretted that Estes could not have examined these several classes himself, since it is quite evident that the wide variation, as found by the Director of the Gymnasium (as low as 9.5%) and his own estimate (as high as 43.6%), represents wide divergencies of opinion as to what constitutes scoliosis.

The collected figures of Scholer, as given by Lovett, a total of 9483 cases, observed by eight men, show 37% of cases with scoliosis.

Scoliosis has usually been regarded as a disease of females, the relationship of cases in females to males being 4:1 (Whitman, *Orth. Surg.*, Lea & Febiger, 1919). These figures are probably based on clinical statistics, and as more girls than boys are usually brought to a clinic for correction of scoliosis, the difference may be explained. When,

Scoliosis 50.3%	None 49.7	Postural Right 1.2%	Postural Left 39.1%	Structural 10.0%
Backache	1.9	0.0	2.7	0.6
Deviation of spine-none	44.2	0.9	27.9	7.3
right	2.8	0.2	5.4	1.4
left	2.7	0.1	5.8	1.3
Round shoulders-none	2.2	0.0	1.0	0.3
group 1	13.2	0.2	11.0	2.7
group 2	21.7	0.5	17.9	2.9
group 3	11.6	0.4	8.5	3.8
group 4	1.0	0.1	0.7	0.3
Increased antero-posterior curvature none	24.8	0.5	14.9	3.9
group 1	6.8	0.3	10.6	1.3
group 2	12.3	0.2	9.3	2.9
group 3	4.9	0.2	3.9	1.6
group 4	0.9	0.0	0.4	0.3
Pelvis level	48.3	1.0	26.8	7.0
low on right side	0.1	0.2	0.1	0.4
low on left side	1.3	0.0	12.2	2.6
Flat chest	26.4	0.8	24.1	4.7
Prominent abdomen	15.3	0.7	22.1	3.6
Legs - equal length	49.0	1.0	26.6	8.8
right short	0.2	0.2	0.1	0.3
left short	0.5	0.0	12.4	0.9
Pronation - none	9.3	0.1	6.1	2.4
group 1	23.2	0.6	14.1	4.4
group 2	12.4	0.3	14.5	2.3
group 3	4.5	0.2	4.2	0.9
group 4	0.3	0.0	0.2	0.0
Arch-high	2.4	0.2	2.4	0.6
medium	28.3	0.7	24.0	5.3
low	18.8	0.3	12.6	4.1
gone	0.2	0.0	0.1	0.0

in a group of nearly 1400 men, one-half are found with scoliosis, it looks as if scoliosis occurred in men about as frequently as in women.

A short leg occurs in cases where no scoliosis is present in .7% of all cases. In right postural scoliosis, a short leg occurs in .2% of cases; in left postural, in 12.4% of cases on the left, and in one case on the right; while in structural scoliosis a short leg occurs in 1.2% of cases. With the idea that unequal pronation or unequal height of the arch of the foot might have some bearing on scoliosis, the results of these cases are tabulated below. It is of course probable that if one foot pronates more than its mate, or if the height of the longitudinal arch varies much, the pelvis will be tilted down to the affected side, and a scoliosis may be the result; on the other hand, it is possible to have a badly pronated foot or a lowered longitudinal arch compensate for shortening in the length of the opposite limb. As the table shows, we found inequalities of the feet in 5% of all cases, and in 3.7% of cases of scoliosis, in which, with a single exception, the lowered foot is on the side of the scoliosis in postural cases, and on the side of the lumbar curve in structural cases.

Scoliosis with Inequalities of Feet	%	Unilateral unequal pronation or inequality of height of longitudinal arch lower on		Length of Legs	
	5.0	right	left	equal	unequal
No scoliosis	1.3	0.4	0.9	1.2	0.1
Postural -- left	2.8	0.1	2.7	2.8	0.0
right	0.4	0.4	0.1	0.4	0.0
Structural	0.5	0.1	0.4	0.5	0.0

FEET.

Very few cases gave a history of foot trouble, but this group of men is of an age and of a type of life where a considerable use of the foot is unnecessary. As college or preparatory school students, they are not called upon to walk more than four or six hours daily. Possibly this reason, as well as their youth, furnishes the explanation of their freedom from foot trouble. The great majority of them have a freely flexible foot. The relationship of pronation, height of longitudinal arch, and the degree of dorsiflexion of the foot are shown in the table. It may be worth noting that about one-fifth of these cases show no

pronation, while two-fifths show pronation of the first degree; that about 95% have an average arch, *i. e.*, either medium or low; and that the dorsiflexion in 80% is over 10 degrees.

In looking over the individual cases of foot trouble, moderate or unequal pronation, low arch, diminished flexibility of the foot, limitation of dorsiflexion, hallux valgus, hammer toes, anterior metatarsalgia, and warts on the sole of the foot were found. There are, to be sure, other cases in which no definite foot disability is evident, which have given the usual symptoms of foot strain.

Foot Table	Pronation					Longitudinal Arch				Dorsiflexion			
	None	Group 1	2	3	4	High	Medium	Low	Gone	Right Angle	5°	10°	15°
Backache	0.5	2.6	1.6	0.5	0.0	0.8	2.6	1.6	0.2	0.3	0.9	2.6	1.4
Foot trouble past-ankle	00.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1
arch	0.8	0.3	1.1	0.9	0.2	0.3	0.3	0.4	0.1	0.5	1.0	0.5	0.1
metatarsals	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
present-ankle	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.1
arch	0.2	0.8	1.1	1.0	0.1	0.1	1.6	1.8	0.1	0.2	0.8	1.8	0.7
metatarsals	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Pronation -- none	17.9					2.7	13.1	2.1	0.0	1.2	2.7	9.8	4.2
group 1		42.3				2.2	28.5	11.5	0.1	0.4	4.7	29.1	8.1
group 2			29.5			0.6	13.4	15.5	0.0	0.8	4.4	18.2	6.1
group 3				9.8		0.1	3.2	6.4	0.1	0.6	1.9	5.0	2.3
group 4					0.5	0.0	0.1	0.3	0.1	0.0	0.2	0.2	0.1
Longitudinal arch-high	1.9	2.6	0.8	0.2	0.1	5.6				0.3	1.4	2.8	1.1
medium	14.0	27.6	13.4	3.2	0.1		58.3			1.4	8.2	36.8	11.9
low	2.0	12.0	15.3	6.3	0.2			35.8		1.2	4.2	22.7	7.7
gone	0.0	0.1	0.0	0.1	0.1				0.3	0.1	0.1	0.0	0.1
Dorsiflexion-right angle	1.2	0.4	0.9	0.5	0.0	0.3	1.4	1.2	0.1	3.0			
five degrees	2.7	4.6	4.6	2.0	0.0	1.2	8.3	4.4	0.0		13.9		
ten degrees	9.7	29.3	18.0	5.0	0.3	3.0	37.0	22.2	0.1			62.3	
fifteen degrees	4.3	8.0	6.0	2.3	0.2	1.1	11.6	8.0	0.1				20.8

TREATMENT.

The treatment of the body defects has been carried out in the gymnasium under supervision in classes of 10 or 12. The student has been shown his defect — whether round shoulders, abnormal spinal curve, flat chest, prominent abdomen, or weak feet. Following this, he has had demonstrated the improvement in physique when he assumes the correct bodily mechanical posture. After this, he has been given corrective exercises to overcome or improve his body defect.

Photographs have been of great help in pointing out to the individual his defect. The photograph taken in his natural standing position, when compared with the one taken in his best standing position, shows him the defect to be overcome, and these pictures repeated dur-

ing or at the end of his course in corrective training show him how much he has accomplished. The man has been urged to carry out these exercises both in the gymnasium and in his room. For weak feet muscle exercises have been given; the individual has been taught the more desirable way of walking; and, when necessary, alterations of shoes have been advised.

RESULTS.

With the help of the instruction in the gymnasium these men have been able definitely to improve their body posture. Should his case have fallen in the third group of round shoulders or in the third group of increased antero-posterior curvature he can improve his abnormality so that his case falls in the second or first group or, in some cases, within normal limits, but this position he is not able to hold naturally. However, when we study the photographs taken after he has undertaken to correct himself, following a course of corrective exercise, it is seen that he has so improved himself that, in many cases, that which was formerly his best corrected attitude has now become his normal way of carrying himself.

CONCLUSIONS.

Students entering college are at an age when bodily defects can be corrected. The type of defect is one which can be improved in practically all cases, and corrected in many. The improvement, as shown in the photographs, where there are present round shoulders, increase in the antero-posterior spinal curvature, flat chest, or prominent abdomen, is sufficient to urge that more time and effort be expended in this field of orthopædics.

Accurate records should be taken and kept which will show the value of this form of therapy.

The value of photography in showing to the student his physical defect is evident. By this means his posture can be accurately recorded more satisfactorily than by any other method.

ASTRAGALECTOMY AND BACKWARD DISPLACEMENT OF THE FOOT. AN INVESTIGATION OF ITS PRACTICAL RESULTS.* †

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THE value of any operative procedure must be judged from three points of view—first, that of its originator; second, that of others who might be expected to possess sufficient skill properly to carry it out; and third, that of the subjects upon whom it has been practised.

It is conceded that many operations have given brilliant results in the hands of their originators, while the results when the same operation was performed by others have not been equally gratifying. Aside from the element of personal bias, this may be due to the exceptional skill of the operator or the exceptional difficulties of the operation. Finally, there is the unhappy result of the performance which theoretically was correct, but which practically the patient did not like. We may, therefore, legitimately require that to be judged successful an operation may be properly performed by one possessed of no extraordinary degree of skill, and that its result, if satisfactory to the surgeon, should at the time be appreciated by the patient.

Of all the operations at the Hospital for the Ruptured and Crippled for the relief of paralytic deformities of the foot, the one performed by far the most often is the Whitman operation — astragalectomy and backward displacement of the foot. It has gradually and steadily outnumbered arthrodesis, tendon transplantation, tendon implantation, etc.

Originally devised for the relief of paralytic talipes calcaneus, its usefulness has become so apparent that it is now employed in the treatment of paralytic valgus and varus, for dangle-foot, for club-foot, and

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†In preparing the following report upon end results of the Whitman operation, it was my intention to examine one hundred cases, taking twenty from each of the past five years. The work of tracing the cases proved so unexpectedly difficult, and the date for finishing my paper—April 28—gave me so little time, that I have been forced to base this report upon sixty cases only, twenty from 1919, and ten from each of the other four years. I hope later, for my own satisfaction, to complete the series of one hundred, but I am convinced that the present number presents a fair average from which to draw conclusions.

occasionally for tuberculosis and osteomyelitis. In this connection it is interesting to note in passing that Dr. Whitman's technique was described in almost identical detail by Dr. Chutro in his address before the American Orthopedic Association in 1919, in dealing with the proper treatment of war wounds of the ankle-joint. It has, then, finally become in one hospital the universal standby, and is looked upon as the operation that will succeed where all others have failed—that may be held in reserve for the relief of almost any paralytic deformity of the foot, and that will promise, even in the worst cases, a painless, stable, and fairly sightly foot.

Upon examining the hospital records and finding a striking preponderance in favor of one operation (see Table 1), one is naturally led to enquire the cause. One would hope to find this due solely to the excellence of the results following its use, but one is also bound to take into consideration ignorance of other procedures that may be as good or better; the force of insularity, or local, institutional or civic prejudice; the purely personal influence of the originator; or finally the strength of tradition.

I therefore determined to investigate the end-results of the operation by examining one hundred cases, twenty from each of the past five years, 1915, 1916, 1917, 1918, 1919. The cases were taken in order as they appeared on the operating record. If the first case in 1915 could not be traced, or refused to return, the twenty-first case was then sent for, and so on, thus obviating the possibility of the results being, as it were, hand picked. They were all taken from Dr. Whitman's service, but were by no means all done by him, as will be seen in the statistics.

As the operation was devised originally solely for the relief of talipes calcaneus, it might seem fair to confine a criticism of its results to that type alone, but as its application has been so widely expanded I decided to investigate an equally wide range of its results. As I was absent on military service from May, 1917, to February, 1919, I had no intimate personal connection with, or knowledge of any number of the cases, nor were they themselves, nor their parents, acquainted with me. They therefore had no hesitation in freely expressing their opinion of the result. As a number of the patients lived at a great distance, and it was obviously impossible for them to return, a questionnaire was included with the original letter, with the idea of getting from the replies no accurate technical information, but a fair idea of what the patients and patients' families thought of the results of their operative treatment. The replies to this form have been gratifying.

TABLE NO. 1.

Year-	Tendon - Transplantation	Astragalectomy-	Arthrodesis-	Gallie - Operation	Miscellaneous
1897	1	5	4		
1898	11	2	5		
1899	55	11			
1900	12	6	1		
1901	22	3	2		
1902	31	13	16		
1903	32	13	43		
1904	13	13	14		
1905	14	9	22		
1906	21	12			
1907	5	18	25		
1908	1	14	19		
1909	4	13	17		
1910	13	37	18		
1911	8	35	7		
1912	12	44	4		
1913	21	54	9	2	
1914	22	80	21	4	
1915	46	100	16	21	
1916	73	92	2	48	Remodelling astraga-
1917	59	100	8	2	lus for calcaneo-
1918	34	103	8	1	varus- 11
1919	32	113	3		Osteotomy thru arch
					5
Total-	542	890	274	78	16

Operations for the relief of paralytic deformities of the foot, performed at the Hospital for the Ruptured and Crippled since 1897, the year of introduction of the Whitman operation.

Astragalectomies -- 890
All other procedures--910

It will be seen from a study of the table of operations that the number of arthrodesis operations has been slowly and steadily decreasing. I may safely say that it is here the current impression that in young subjects, and particularly those suffering from paralysis, whose bones are notoriously soft, it is impossible to obtain a true bony ankylosis. A deceptive degree of stiffness may be evident for months after operation, and combined with other procedures, such as tendon transplantations, this stiffness may be utilized, and even prove sufficient to its subsidiary rôle. Corrective operations depending solely for their success upon the formation of a bony ankylosis have been observed to be failures. Indeed, one of the strongest bits of corroborative evidence lies in the results of the Whitman operation. Were bony ankylosis to be expected from removal of cartilage and the apposition of bleeding, bony surfaces, one would certainly find it in astragalectomy, where it is our custom to reshape both malleoli and insert them in beds prepared by removing sufficient cartilage and bone to permit of their snug reception. Their stability in this position is maintained by suture and by plaster of Paris. That it is the wide impression that such technique must result in ankylosis may be evidenced by the following quotations: *"Although it would seem that a sufficiently destructive removal of joint surfaces would surely result in anchylosis, the fact remains that skillful and experienced surgeons will *occasionally* fail to secure a stiff joint." Later, speaking of astragalectomy itself, *"because in the modified operation as performed in the Children's Hospital, Boston, an ankylosed ankle is not aimed at."

As a matter of fact, in not one of this series of cases examined has there been ankylosis at the ankle joint. The limitation of motion has been entirely dependent on the degree of backward displacement of the foot upon the leg, and failure of the operation has been due to too much motion rather than to stiffness.

The purposes for which the operation has been done are as follows:

1.—For calcaneus. The object here is to check deformity, to attain stability, to dispense with apparatus, and to provide a functionally passive foot with propulsive power.

2.—For dangle-foot. The object of the operation in this condition varies according to the degree of paralysis. If the weakness be chiefly

*R. W. Lovett. Treatment of Infantile Paralysis, p. 118, 2nd Edition, P. Blakiston's Son & Co., Philadelphia.

below the knee, the operation will provide a symmetrical extremity and enable the patient to discard apparatus. If the paralysis involves the entire extremity, the operation has frequently been done simply to give a stable foundation and to permit brace-wearing with comfort. Also in paralysis of the quadriceps extensor, when the resistance to dorsal flexion will lock the knee in extension and thereby assure stability of the limb.

3.—For advanced varus or valgus deformity. It has usually been done in this class after the failure of other operative procedures and is looked upon as a last resort. It should, as a rule, be combined with tendon transplantation.

It is thus evident that the result which we may expect from the operation will vary according to the class of case in which it was performed. In reviewing the series, I have, however, grouped them all together. To class a result successful I have required that dorsal flexion should be checked at a right angle, that there should be no appreciable lateral deformity when weight is borne, and that apparatus, when it is worn, should be worn with comfort. The opinion of the patient must also be satisfactory. There have been cases puzzling to classify: for example, in which the patient was satisfied with a degree of varus deformity, for which the surgeon would recommend correction (Case No. 22). In such cases the surgeon's opinion has been given the greater authority. In fact, as such research as this should be definitive, the emphasis throughout has been placed on criticism rather than appreciation.

As the audience for which this paper is written represents the discriminating few, it is well to take into consideration all the points which here influence our judgment in the choice of operation. It will be evident at once that we regard the Whitman operation as the ultimate resource, and that its preponderance over other operations, and the number of conditions for which it is being done, is constantly increasing. At the same time it must be remembered that the circumstances of the patient greatly influence the choice of operation, and that hospital and private practice must always differ. This is also true in contrasting the methods of a large and very busy institution with one treating a smaller number of cases. An operation that may be satisfactory in private may be a failure in hospital practice. We have found, for example, that certain tendon transplantations give beautiful results when they can be assisted by accessories, such as built-up shoes, foot plates, and muscle training; or, in other words, proper postoperative supervision. The identical condition minus post-

operative care will result in failure. Such a statement sounds so brutal in this generation of Social Service and Follow-Up Work, that I cannot let it stand unqualified. Orthopædic postoperative care should end at the grave, and patients intelligent enough to appreciate that fact, and sufficiently persevering, and in adequate circumstances to act upon it are few. At least the intelligence and the circumstances are rarely found in combination, and postoperative care that in general surgery may be taken for granted, in orthopædics practically comes under the head of luxury; as we found in collecting this series of cases, those who lived at a distance simply could not come. They were not necessarily indifferent, as their replies showed, but they could not afford the time and money to visit the hospital. This fact, then, has led us to choose the Whitman operation in a number of cases which elsewhere might be regarded as proper subjects for other procedures.

In spite of the fact that the members of the American Orthopedic Association are probably all thoroughly familiar with the details of the operation, in order to avoid any possible misconception, I think it best to describe briefly its technique.

"The line of incision begins at a point about an inch above the extremity of the external malleolus midway between it and the tendo Achillis, and is continued downward and forward about three quarters of an inch below the malleolus over the dorsum of the foot to the external surface of the head of the astragalus.

The sheaths of the peronei tendons are opened and the tendons are cut below the malleolus and drawn backward. The bands of the external lateral and interosseous ligaments are divided and the head of the astragalus is freed from its attachments to the tibia and the scaphoid. An elevator is then inserted between it and the os calcis, and the foot being forcibly inverted, the head of the astragalus is drawn from the wound, and, the attachments on its inner and posterior borders having been cut or broken, it is removed.

One then prepares the new articulations. A thin section of bone is cut from the adjoining external surfaces of the cuboid and the os calcis and turned back to form a flap. On the inner side a knife is passed about the superior and internal surface of the scaphoid, and the tissues are separated by an elevator. The foot is then displaced inward and the malleoli are laid bare by dissection from their ligamentous attachments and are reshaped somewhat on their internal surfaces to fit the new articulations. The peronei tendons, freed from the lower extremity of the fibula, are passed through a slit at the base of the tendo

Table No 2

		Age of patient	For calcaneus.	For deformity	For stability.	Operator.	Satisfactory	Improved	Poor	Apparatus worn.	Apparatus discarded.	Am't of shortening.	Parent's opinion.	Both Limbs Paralyzed.	Secondary to other operations.
1-Jeanette A.		14		--			--				--		s		
2-Ruth E.		13		--		1	--						s	--	
3-Emil G.		11	--			W	--				--	1/4	s		
4-Rose K.		12		--		W	--				--	0	s		
5-Jacob N.		14			--	2	--			--			s	--	
6-Yetta O.		13	--			3	--			--		0	s	--	
7-Anna S.		14		--		3	--				--	1/4	s	--	(a)
8-Irving S.		13	--			3	--				--	0	s	--	
9-Vito R.S.D.	(R)	12	--			3	--						s	--	
10- " "	(L)	12			--	1	--						s	--	
11-Robert B.		10		--		W	--					3/4	s		
12-Rose D.		13	--			4	--					1/4	s	--	(b)
13-Helen F.		10	--			W	--					1/2	s		
14-Ida L.	(L)	9	--			W	--				--		s	--	
15- " "	(R)	"			--	W	--			--			s	--	
16-Annie L.	(L)	16	--			W		(c)		--			s	--	(d)
17- " "	(R)	"			--	W	--			--			s	--	
18-Mary McC.		13			--	W	--						s	--	
19-Martha M.		23			--	W	--				--	1/2	s		--
20-James S.		8			--	5	--				--	1 1/8	s		
21-Arthur B.		9		--		6	s			--		5/8	s		
22-Martin D.		12			--	6		(e)		--		1/2	s		
23-Julius E.		12				W	--				--	3/4	s		
24-Yetta L.		14	--			7	--			--		1/2	s		
25-Eric J.		17		--		W	--					1	s		(f)
26-Minnie S.		8			--	5		(g)				1/2	(h)		
27-Frank M.		9	--			8	--					7/8	s		
28-Molly M.		14		--		9	--						s	--	
29-John H.	(R)	14			--	7	--			--			s	--	
39- " "	(L)	"			--	6	--			--			s	--	
31-Gladys B.		12			--	10			(i)		--	3/4	(j)	--	
32-Alfred C.		14			--	W	--			--		1/2	s		
33-George C.		14	--			11	--				--	5/8	s		
34-Mary G.		7	--			W	--			--		1/4	s		
35-Catherine C.		13			--	10		(k)		--		3/8	(l)		
36-Clarence J.		8	--			W	--			--		7/8	s		
37-Emanuel K.		11			--	5	--				--	1	s		
38-Hilda P.		12			--	W	--					0	s		
39-Nathan R.		13	--			W		(m)				1/2	(n)		
40-Dora S.		8			--	6	--					1/2	s		(o)
41-Peter B.		4½	--			8	--				--	1/2	s		
42-Frances C.		4½	--			W	--				--		s	--	
43-Florence C.		5	--			5		(p)				5/8	s		
44-Michael C.		7			--	W	--			--		1/2	s	--	
45-Helen E.		5	--			5	--				--	3/8	s		
46-Johanna F		5	--			W	--				--	1/2	s		
47-Eva G.		5	--			W	--				--	5/8	s		
48-Oscar G.		4	--			W	--				--	1/4	s		
49-Richard G.		5			--	8		(q)		--			?	--	
50-Edith H.		9	--			W	--				--	1/2	s		
51-Philip J.		16		--		8	--				--		s	--	
52-Patrick K.		11		--		A.W.	--						s	--	
53-Mary McC.		13		--		W.		(r)					s	--	(t)
54-Matilda M.		21	--			W	--						s	--	
55-Joseph R.		11		--		5	--				--	3/4	s		
56-Murray S.		4½	--			W	--				--	1/4	s		
57-Theodore S.		5			--	W	--				--	1/4	s	--	
58-Mary T.		6	--			2	--					1/4	s		
59-Herbert W.		13			--	6	--				--	1/4	s		
60-Catherine W.		24		--		W	--					1/4	s		

KEY TO DOCTORS INDICATED IN SIXTH COLUMN OF TABLE 2.

1 Strickler.
2 Cilley.
3 Wolcott.
4 O'Neil.
5 Kleinberg.
6 Wallace.
7 Raia.
8 Whitbeck.
9 Zadek.
10 O'Brien.
11 Dupuy.

REFERENCES IN TABLE 2.

(a) Tendon transplantation.
(b) 1912—Ext. Comm. Dig. attached to scaphoid—1914—Davis operation.
(c) Dorsal flexion limited at 80 degrees.
(d) 1. Tendon transplantation. 2. Astragalectomy, resulting in insufficient backward displacement, for which a third operation was done.
(e) Insufficient backward displacement, although dorsal flexion is checked at a right angle—slight valgus.
(f) Tendon transplantation.
(g) Insufficient backward displacement, although dorsal flexion is checked at a right angle—slight varus.
(h) Child easily tired.
(i) Forty-five degrees equinus.
(j) Failure.
(k) Slight equinovarus.
(l) Fair.
(m) Dorsal flexion to 135 degrees.
(n) Improved.
(o) Gallie operation.
(p) Slight varus.
(q) Insufficient backward displacement.
(r) Insufficient backward displacement.
(t) Tendon transplantation.

Achillis, sewn firmly to it, and then drawn forward and reunited to their distal extremities to serve as ligaments.

The foot is now displaced backward, the external malleolus covers the external aspect of the calcaneocuboid articulation, the internal overlaps the navicular. The above mentioned flap is turned upward and sutured to the external malleolus by a mattress suture of chromic gut.

The wound is then closed with catgut sutures and the foot is fixed by a plaster splint in an attitude of moderate plantar flexion and abduction. Except in older subjects and in extreme cases, the peroneal tendons are now neither divided nor transplanted, as the loss of the peroneus longus tends to induce varus deformity if the tibial muscles are active.

In the routine of hospital practice the operation is performed under the Esmarch bandage. The tendons are sutured with kangaroo tendon. The wound, having been cleansed with warm saline solution, is closed without drainage. The foot and limb are bandaged with sterilized sheet wadding, over which a light plaster is applied, holding the foot in the attitude described, and the leg at a right angle to the thigh. The limb is afterwards suspended between tapes running from the head to the foot of the bed. Great care is taken to avoid constriction. To this, and to the rest assured by the plaster splint, and to suspension, is ascribed the very slight discomfort following the operation, and the absence of complications.

At the end of about three weeks the first support is removed, and the walking plaster splint is substituted, extending to the knee, and fixing the foot in the same attitude of moderate equinovalgus, the sole being equalized by the incorporation of a wedge of cork. The patient is encouraged to walk with equal steps, and to bear weight on the forward part of the foot. At the end of from two to four months the new joint will have become stable, and the fixed support may be discarded for a shoe arranged with a cork wedge beneath the heel, of sufficient thickness to compensate for the slight equinus, and if necessary, the outer border of the sole is thickened somewhat to prevent a tendency to inversion.

The patients are directed to report at stated intervals for supervision. As time goes on, the heel may be raised, if necessary, more and more, to compensate for any preëxisting shortening of the limb. As a rule, the thickening of the outer border of the sole may be discarded in a comparatively short time. When it is discarded, however,

Table No. 3

	Age of patient.	For calcaneus.	For deformity.	For stability.	Operator.	Satisfactory.	Improved.	Poor.	Apparatus worn.	Apparatus discarded.	Am't of shortening.	Parent's opinion.	Both limbs paralysed.	Secondary to other operations.
1915-ten cases. (Nos. 1-10)	8	4	4	2	W-2 0-8	10			2	5	$\frac{1}{10}$	5	6	1
1916-ten cases. (Nos. 11-20)	8+	4	1	5	W-8 0-2	9	1		3	3	$\frac{5}{8}$	s-9 1-1	6	3
1917-ten cases. (Nos. 21-30)	9+	2	4	4	W-2 0-8	8	2		5	1	$\frac{19}{28}$	s-9 1-1	3	1
1918-ten cases. (Nos. 31-40)	9+	4	0	6	W-5 0-5	7	2	1	2	5	$\frac{43}{80}$	s-7 1-2 f-1	1	1
1919-twenty cases. (Nos. 41-60)	8+	11	5	4	W-11 0-9	17	3		2	12	$\frac{15}{28}$	s-19 d-1	8	1
Total-60 cases.	8	25	14	21	W-28 0-32	51	8	1	14	26	$\frac{273}{560}$	s-54 1-5 f-1	24	7

O=others.

parents are instructed in daily manipulations of the foot, and told that they must be continually on their guard against the development of a tendency to varus deformity.

The total of sixty cases examined shows satisfactory results in fifty-one. Eight patients are improved, and one operation was a failure. Fifty-four of the parents, or patients themselves, were satisfied with their condition. From the surgeon's standpoint 85% of the results were satisfactory—from the personal standpoint 90% (see Table No. 3).

The conclusions derived from the investigation are as follows.

1. The operation gives the best results functionally and cosmetically —*i.e.,* the percentage of improvement is greater—in the class of cases for which it was originally designed—talipes calcaneus. It corrects deformity and changes the most crippling variety of talipes into a functionally useful foot. In this field it comes as near being a curative performance as any operation for the relief of paralysis can be.

2. In dangle-foot, with or without varus or valgus deformity, it provides a symmetrical and stable foot, and, unless the paralysis of the extremity is so severe as to require the use of a long brace, enables the patient to dispense with apparatus. It does not correct the degree of drop-foot which may take place at the mediotarsal joint, but as the

Table No. 4.

ANALYSIS OF UNSATISFACTORY RESULTS.

1 Florence C. Case 43—Operated June 23, 1919,—left calcaneus, slight tendency to varus. Has had no after-treatment whatever, owing to bad home conditions.
2 Richard G. Case 49—Operated June 23, 1919,—calcaneus, dorsal flexion checked at 80 degrees. Insufficient backward displacement.
3 Mary McC. Case 53—Operated May 19, 1919,—right valgus, secondary operation. Dorsal flexion checked at 80 degrees, still has considerable valgus deformity.
4 Gladys B. Case 31—Dangle foot in equinovarus—operated June 24, 1918. Has a resistant equinus deformity—operation a failure. Has had no post-operative supervision.
5 Catherine C. Case 35—Right varus deformity—operated September 9, 1918. Still has varus deformity, due to slight power in the tibialis anticus and posticus. Should have a supplementary tendon transplantation.
6 Nathan R. Case 39—Right calcaneus—operated January 21, 1918. Has dorsal flexion to 45 degrees in spite of good backward displacement of the foot. Result classed as unsatisfactory, though the patient prefers his present state to that before the operation.
7 Martin D. Case 32—Dangle foot—operated October 29, 1917. Slight valgus and insufficient backward displacement of the foot, though dorsal flexion is checked at a right angle.
8 Minnie S. Case 26—Left dangle foot in equinus, operated March 31, 1917. Very slight tendency to varus, not quite sufficient backward displacement.
9 Annie L. Case 16—Left calcaneo-varus—operated 1916. Dorsal flexion limited at 80 degrees—insufficient backward displacement.

extremity is usually short anyway, requiring of itself the wearing of a high heel, this degree of drop-foot has not in any case been severe enough to require the wearing of apparatus for its correction.

3. For varus or valgus deformity the operation has usually been done as a last resort. The cosmetic results are not as satisfactory as in the former classes, nor is the cure of deformity likely to be permanent unless the operation be supplemented by tendon transplantation or implantation. I feel that it should be recommended in these cases only when other procedures have failed, or when we know that any after-care is out of the question.

From a study of the bad results (see Table No. 4) we have proved two major causes of failure. The first is insufficient backward displacement of the foot, which, with one exception in this series, is accepted as evidence that the original operation was improperly performed.

The second is varus deformity. This may result from:

(a) Faulty operation—failure to place the external malleolus sufficiently far forward.

(b) Persistence of the original deforming factor, be it only a trace of power in either the tibialis anticus or posticus.

(c) The removal of the support afforded by the head of the astragalus to the scaphoid, which occasionally will produce varus deformity in even completely paralyzed extremities.

The first case is too simple to need comment. For Class B we are inclined to recommend transplantation of the deforming agent at the time of or shortly following the original operation. All cases should be treated with the development of this deformity in mind, with a shoe raised on the outside, and with the parents instructed in the daily manipulations of the foot. It is only where these simple precautions have been neglected that deformity in Class C has occurred.

It will be seen, that while the average age of the 1919 cases is no less than that of preceding years, there is a greater proportion six years or under (55%), than in any of the other groups. This fact represents a new departure in treatment, as the youngest operative cases are those of the 1916 epidemic. It may be said that whereas it was the custom formerly to delay operation for almost an indefinite period following the onset of the disease, we now feel that a delay of more than two years is unnecessary. We realize that there is always, under operative treatment, massage, muscle training, or electricity, the possibility of a certain regeneration of muscles that at a primary examination might have appeared to be totally paralyzed. The return of power to the flexors of the toes following astragalectomy, for example, has become a familiar phenomenon in this hospital. Except in cases which have been absolutely neglected and been suffered to run wild, with resultant deformity or manifest constant over-fatigue, there is not likely, after two years, to be a return of power to a muscle sufficient to be of practical value from a locomotive point of view.

Upon this premise, then, we are now, April, 1920, starting the operative treatment of the 1916 cases, upon the theory that a proper operative result will permit the discarding of apparatus and result in the greater functional efficiency of the limb. It is our hope and belief, that the earlier the functional use, the less will be the eventual atrophy of the entire extremity. Particularly do we hope to check the extreme atrophy and distortion incident to talipes calcaneus.

One of the most striking facts brought out by the investigation is in relation to the patient's brace-wearing. The operation enabled the discarding of all apparatus upon the affected limb in twenty-six cases. Only fourteen out of sixty wear apparatus at all, and in all of these it is worn because of paralysis above the knee.

The removal of the astragalus causes an average shortening of half an inch, for which it is our custom to compensate by the wearing of an inner heel. None of the patients mentioned this shortening as a cause of dissatisfaction. This is of interest chiefly because a writer of some prominence has characterized the operation as "mutilating."

A study of statistics will doubtless be of more value than my personal opinion. As the study of statistics is sometimes deferred until a time never attained, I may, perhaps, be excused for ending this paper with a simple statement:

Sixty cases were examined, of which twenty-eight were operated on by Dr. Whitman and thirty-two by other surgeons on his service. Eighty-five per cent. of the results were successful. Sixty five per cent. of the patients wearing apparatus were enabled to discard it. One patient regarded the operation as a failure. Ninety per cent. were satisfied with their condition.

Those who are really interested in the subject can gain satisfactory information from a study of the case records. They will there find that all but three of the bad results may be—and indeed several have already been—corrected by measures varying from simple manual stretching to secondary operation for further backward displacement of the foot upon the leg. They will observe that most of these procedures might have been obviated by elementary postoperative care.

The fact in the study of these patients that is to me most striking is that in spite of the variety of disabilities to which the application of this operation has been expanded, and in spite of the hard conditions of this particular hospital practice, its results are so satisfactory to the patients themselves. That its results are also good from the standpoint of technical criticism is only further testimony to the theoretical soundness of its conception.

LENGTHENING OF THE QUADRICEPS TENDON.

BY GEORGE E. BENNETT, M.D.

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In the September, 1919, issue of the *Journal of Orthopaedic Surgery* we published a paper entitled "Preliminary Report of Lengthening of the Quadriceps Tendon." In this article we called attention to the part the quadriceps tendon played in the loss of mobility of the knee joint, following lesions of the femur, such as fractures, simple and compound, osteomyelitis of the femur, fractures of the tibia and fibula, and ununited fractures of bones above and below the knee joint, requiring long immobilization.

It is a well-known fact that in a small percentage of cases such as have been enumerated, one sees a permanent loss of complete or partial flexion of the knee joint, notwithstanding the fact that the lesion has been entirely an extra-articular affair.

Attention was also called particularly to the part the quadriceps plays; contractures, adhesions, and other conditions to which muscles may be subjected, and three cases were reported in which we had succeeded in increasing the range of motion by lengthening the tendon, and the methods of procedure were described. Since that time the number of cases has increased to eight, seven of which have unquestionably had very satisfactory results, while the eighth case only showed no improvement.

Even at the expense of being accused of reiteration, we think it would be well to touch lightly on the anatomy of the anterior thigh, since in a description of the operation itself, it is very necessary that this point should be perfectly understood. The relationship between the crureus and vastus internus and externus muscles is very close in the lower third of the femur, and their tendons are inseparable. The crureus, lying deepest of the three and on the anterior surface of the shaft of the femur, is easily tied down by adhesions, thereby rendering absolutely inert the function of the other three muscles forming the quadriceps. We feel perfectly free in making this rather startling assertion, as we have seen a case where the rectus, by adhesions high

up in the thigh, had produced a complete loss of motion of the knee joint. If this can be true of the most independent section of the quadriceps group, why should it not be true of the less independent members, that is, the vastus internus and externus and crureus?

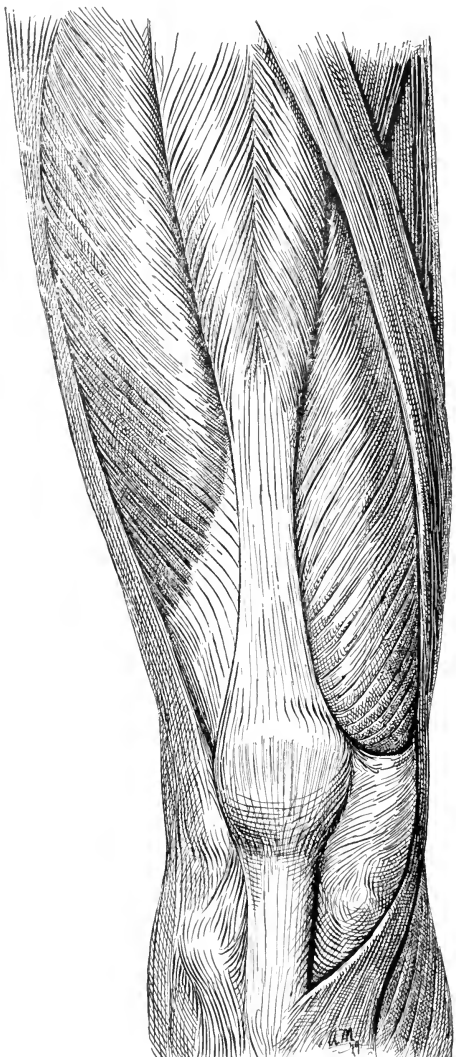


Fig. A.

In our former article no note was made of changes in the capsule of the knee joint, because we were very much surprised to find, in the first two cases on which we operated, very little, if any, evidence of contraction, hardly as much as one would anticipate from lesions

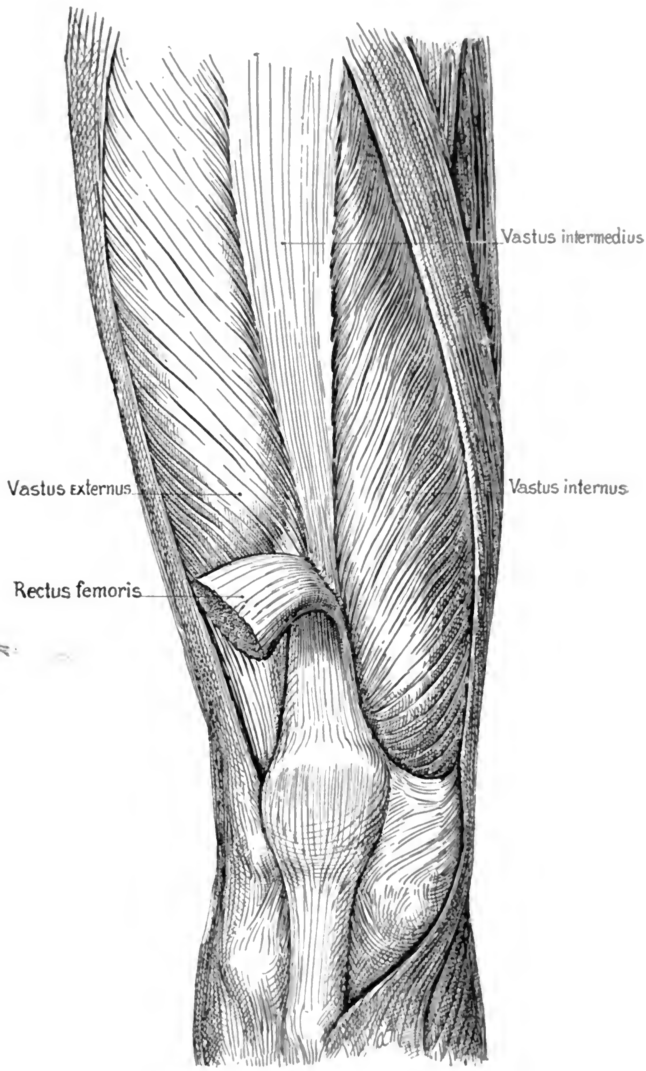
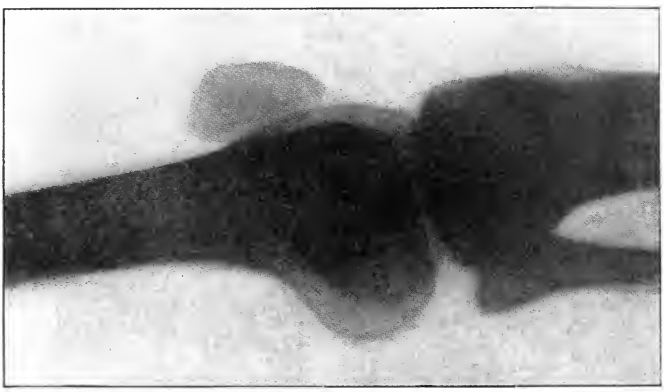


FIG. B.

which had existed over a period of from six months to seventeen years. Our third case did demonstrate, in a mild degree, certain changes in the capsule, but not as marked as one had been led to believe in older instructions.

We believe that the changes within the knee joint itself are comparable with the changes which one would expect to find in the ankle joint, if the tendo Achillis was lengthened to correct an equinus deformity that had persisted for a long time. In other words, we recognize capsular changes. There is a certain amount of obliteration of the quadriceps pouch, but we wish to emphasize that the chief offender in the production of this condition is the contraction of the quadriceps tendon and adhesions. The capsule is entirely a secondary affair, and will take care of itself, — will, in fact, be totally relieved, when the tendon contraction has been overcome.

We believe that this problem can be more clearly understood by following a rather detailed recital of the histories of the cases which have been operated on; a study of the problems which presented themselves with each case, of the changes noted, and of the end result.



X-ray of knee before operation. Case 1.

Case No. 1. N. C. Age 34. (Previously reported in *Journal of Orthopaedic Surgery*, September, 1919.) Admitted to Johns Hopkins Hospital June 19, 1917.

Diagnosis: Old healed osteomyelitis of upper third of femur. Old healed osteomyelitis of the clavicle. Contraction of the quadriceps tendon.

Complaint: Stiff knee.

Family History: Unimportant.

Past History: Unimportant.

X-ray. Osteomyelitis upper third femur, which tied down the fibres of the rectus. Case 1.

Photograph before operation. Case 1.

Present Illness: Onset after injury to spine at the age of six or seven. Following this injury, the patient was unable to sleep at night for about one month. Right leg became swollen, and there was marked pain. Patient was confined to bed six or seven weeks. After this he walked with crutches. In the meantime abscesses had formed and broken down. Relief from pain after the evacuation of the abscesses was marked. Abscesses continuing to form at the rate of about two each year for several years. At the age of ten, an abscess appeared on the left clavicle; this was treated surgically, as well as one on the right arm. Several pieces of bone came from the thigh abscesses at different times. At the age of fifteen, the right knee became stiff, and has remained so ever since. Reaching the age of twenty-one, the patient has had no more abscesses. He comes to the hospital to see if motion can be obtained in the knee.

Previous Operation: January 17, 1914, was admitted to Johns Hopkins Hospital. Exploration of upper thigh and attempt to relieve contracture and adhesions was without result. Re-admitted to Johns Hopkins Hospital on June 19, 1917, for operation reported in this article.

Physical Examination: (Reported from Johns Hopkins Hospital History.) There is rather marked atrophy of the muscles of the right thigh. Calves appear the same size. There is a long scar just below the greater trochanter on the right thigh, which is adherent to the bone. Normal motion in right hip. Flexion of knee is limited to fifteen degrees, with marked contraction of the quadriceps tendon when knee is forcibly flexed. Lateral motion of knee seems fairly free. Scar of former operation over left clavicle. Atrophy of right thigh is thirteen cms. Atrophy of right calf is one-half cm.

Operative Note: (Report from Johns Hopkins Hospital History.) Operation June 25, 1917. Manipulation of right knee. Lengthening of quadriceps femoris tendon, right. Iodine technique. After patient was fully anesthetized, the right leg was brought over the end of the stretcher, and with the pelvis firmly held to the table the leg was flexed on the thigh for several minutes in an effort to break up joint adhesions. Approximately five degrees of flexion were gained in the manœuvre. It was noticed that, although the knee could not be flexed more than twenty degrees, lateral motion in the knee joint appeared quite free, and that the patellar and quadriceps tendons were apparently contracted and limiting joint motion. The thigh was then cleaned up with iodine and alcohol and a long incision was made over the quadriceps tendon. The knee was allowed to flex over a pillow. The tendon of the rectus

Case 1. N. C. End result.

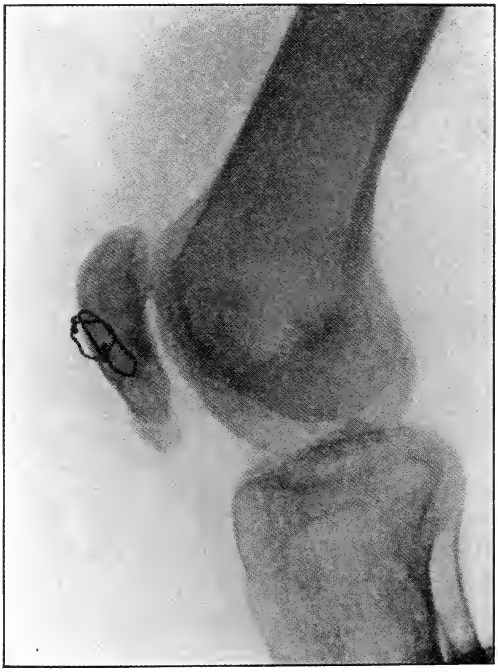
femoris was tightly contracted. This was divided and the fibres of the vastus internus and externus dissected loose. The leg could now be flexed ninety degrees, and motion was quite free. The vastus externus and internus tendons were sutured to the distal end of the cut rectus femoris tendon with several sutures of heavy braided white silk. Subcutaneous tissue was closed with interrupted sutures of plain catgut and the skin with continuous fine black silk suture. Sterile dressing.

DISCUSSION

Patient made an uneventful recovery from operation, and at the end of four weeks was walking about with eighty-five degrees of motion. This has continued until, at the time of writing, he has approximately one hundred and twenty degrees of free, painless motion, with a quadriceps tendon in full power. This enables him to perform his occupation as carpenter. He states that he is able to carry one hundred and fifty pounds on his shoulder, going up stairs foot over foot without any discomfort.

The points of particular interest in this case are the duration of the loss of motion in the knee over a period of seventeen years before

operation, no contraction of the capsule noted at the time of operation, and that the structures of the knee joint were in very good condition prior to operation. The rectus tendon was the element at fault, with adhesions in the upper thigh, and contraction of the quadriceps tendon.



X-ray before operation. Case 2.

Case No. 2. Mrs. M. B. (Previously reported in *Journal of Orthopaedic Surgery,* September, 1919.)

Comminuted fracture of right patella. August 17, 1917—Open operation and wiring. Immobilization in extension. Massage begun October 20, 1917.

Manipulated under anesthesia and continued treatment until operation February 4, 1918, at which time patient had thirty-five degrees of motion, as shown in X-ray taken with leg held in forced flexion.

DISCUSSION

This patient had ideal treatment following removal of plaster splint, constant massage and apparatus work, but in spite of this only thirty-five degrees of motion were obtained at the end of four months.

A full normal range of motion came four months after operation. Approximately one year after operation motion in the knee became painful

X-ray ten weeks after operation. Case 2.

from a thickening of synovia, caused by a large patella. A reduction of the size of the patella relieved all discomfort. Patient is able to ride horseback and lead an athletic, active life.

No capsular contraction was noted at time of operation. It is our opinion that this was an example of contraction of the quadriceps group.

Case No. 3. G. J. G. Age 23. White male. (Previously reported in *Journal of Orthopaedic Surgery*, September, 1919.) Admitted to Johns Hopkins Hospital March 13, 1919. Discharged April 29, 1919.

Case No. 4. G. J. G. Age 23. White male. Admitted to Johns Hopkins Hospital June 29, 1919. Discharged August 23, 1919.

Family History: Unimportant.

Past History: Unimportant.

Present illness: In an automobile accident June 25, 1915, patient sustained a compound fracture of the right femur, eight inches above the knee, and a simple fracture of the left femur, six inches above the knee. Both limbs were put up in traction and the wound on the right thigh irrigated daily. At the end of three weeks an open reduction of the fracture on the left was done, the fragments being plated and the limb being put up in a long plaster hip spica. The wound on the right closed at the end of nine weeks, at which time a plating operation was

Photograph four months after operation. Case 2.

done on this side, and a long spica applied. The cast on the left side was cut an inch or so shorter at various times, so that it was not until October of that year that the knee joint was exposed. By the end of December, 1915, the right knee was also free for motion; massage and later manipulation were instituted. However, the legs remained stiff at the knees. In August, 1918, several manipulations under anesthesia were unsuccessful. On September 12th, the bone plate of the right was removed without improvement. Stiff knee condition remains as on admission.

Physical Examination: Right leg: The patient walks with both knees stiff. There is a large scar over the middle of the lower end of the femur extending over the external condyle to the patellar tendon, evidence of operation for relief of adhesions and plating operation for compound fracture.

Left leg: Scar on the outer border of the lower third of femur, result of operation for fracture. Some thickening of the femur. Patella freely

movable. Fifteen degrees of flexion can be obtained, when a sudden shock is felt and the quadriceps tendon becomes taut.

Operative Note: Left leg—March 13, 1919. Iodine technique. Incision was about nine inches long, beginning at the patella and extending upward parallel to the femur. The subcutaneous tissues were divided and dissected laterally. These were then retracted, exposing the quadriceps tendon. There was found to be considerable scar tissue about the quadriceps tendon, and it was firmly adherent to the femur about four inches above the patella. These longitudinal incisions were then carried laterally, so as to divide the tendinous portion of the vasti muscles. This left about four inches of the quadriceps tendon, three-quarters of an inch wide, attached to the patella. The tendons of the vasti muscles were then dissected free where they were tied down, and with considerable force the leg was flexed almost at right angles. Dissection was made with considerable difficulty, as all the tissues were tied down very firmly to the femur. The capsule was also quite adherent to the tendon, so that in making the dissection the capsule was punctured in one place near the upper portion of the patella. With the leg flexed almost at right angles, the central portion of the tendon which was still attached to the patella was sutured to the vasti muscles in a lengthened position, leaving a space of nearly three inches above the central portion open. The vasti were then sutured across the open space, and sutured also firmly to the central portion of the quadriceps tendon. This gave a lengthening of the quadriceps tendon of about three inches. Chromic catgut and braided silk were used in this suturing of the tendon. The deep tissues were sutured over the quadriceps tendon with chromic catgut. The superficial tissues were closed with plain catgut. The skin was closed with silk. Plaster cast was applied from toes to groin with knee flexed at eighty degrees. Patient left the table in good condition.

Post-operative Note: The post-operative course on the whole was uneventful. Some ecchymosis appeared about the thigh. The temperature went up to as high as 101 on several occasions the first week. After that, however, the condition was excellent. On the 27th day of March the cast was removed. The wound was found healed *per primam.* The knee could be flexed to 100 degrees without any discomfort. Following this, a mild course of massage, with later manipulation, was begun. At the time of discharge, the patient was able to actively extend his knee to within fifteen degrees of normal. Limb could be flexed to eighty degrees. There was practically no local discomfort.

Cases 3 and 4. G. J. G. Right leg in forced flexion before operation, showing degree of motion.

Operative Note: Right leg—June 30, 1919. Case No. 4. Iodine technique to the skin. An incision was made on the anterior aspect of the thigh from about the middle of the thigh running down longitudinally to a point just over the lower margin of the patella. It was carried through the skin and the subcutaneous tissues to expose the quadriceps tendon. There was a lateral dissection of the skin, permitting an exposure of the entire width of the rectus femoris muscle, together with the insertion of the vasti into its lateral border. Owing to the numerous adhesions between the various tissues, the dissection proved to be more difficult, and there was more bleeding than usual. With the muscles exposed, efforts at flexion showed that most of the restriction of flexion was due to the binding down of the tendon by the lower fibres of the vastus internus muscle. In freeing the quadriceps tendon from these restricting bands, an incision was made from the middle of the lateral margin of the patella to the junction of the rectus tendon to the body of the muscle. A similar incision was made on the inner aspect of the

Cases 3 and 4. G. J. G. Left leg in forced flexion before operation, showing degree of motion.

rectus femoris, the upper end of the incisions being connected by a curved incision line. This left the patella with its upper portion attached to a tongue of tendinous tissue, free from the vasti on either side, and from the belly of the rectus muscle above. This flap was then dissected up from the underlying tissues, care being taken not to enter the joint cavity. Flexion then proved to be restricted by intra-capsular adhesions. With a little forceful manipulation, however, these adhesions could be broken, and 120 degrees of flexion of the knee obtained. The problem of resuturing the tendon into its lower position was then begun. With the leg flexed at 80 degrees at the knee, the tendon was sewed rather tautly to the vastus internus. In order to further facilitate the slipping of the tendon, a pad of fat about three inches in diameter was dissected out from the subcutaneous layers of the outside of the thigh, and placed underneath the rectus tendon. The outer side of this was then pulled up

Cases 3 and 4. G. J. G. End result.

as high as could be, with the knee in the flexed position, and then sewed firmly to the tissues of the externus vastus which had previously been dissected up. The upper portion of the tendon was pulled as far as could be managed to the belly of the rectus muscle. The cavity left was closed over by the joining together of the lateral margins of the space. All the suturing was done with chromic catgut, and the skin, by means of a locking silk continuous suture. It was found, however, on effort to close the skin, that the contracture of the skin had been so great that the incision edges would not unite in the newly flexed position without extreme tension being made on the skin. To relieve some of this tension, two longitudinal incisions were made about an inch to either side of the

Cases 3 and 4. G. J. G. End result.

incision line. The improvement in the circulation of the tissues was quite noticeable when these incisions were made. These relaxation incisions were just through the skin. Dry dressings were applied and a plaster cast put on with the knee flexed 80 degrees. Patient stood the operation well.

Post-operative Note: July 1, 1919. Patient feels fairly comfortable. Temperature 100.2. Cast in good shape. Circulation in toes good.

July 2, 1919. Because of rise of temperature to 101.2, a white count was done. This showed 11,000 leukocytes. Patient feels fairly well. Appetite has not yet returned. Circulation in toes good.

July 5, 1919. A window was cut in the cast at the knee. There were several blood clots at the side of the two lateral incisions. Slight oozing of these wounds took place. Incisions were washed with alcohol and dressed with gauze. Patient's temperature fell to 99.8 after the dressing,

but at 7 p. m. was up to 100.4. Patient feels well. The tissues about the knee are black and blue.

July 7, 1919. Hot boric compresses applied to knee. Patient feels well. Highest temperature 99.8. The area of discoloration is more evident on the lateral aspect of the knee.

July 10, 1919. Skin in very good condition, ecchymosis cleared up. Stitches removed. Temperature normal.

July 20, 1919. Anterior half of cast removed: posterior half padded and bandaged to the leg.

July 22, 1919. Leg extended until it lacked thirty degrees of full extension.

July 25, 1919. Patient getting around on crutches. Feels that right leg is weaker possibly than the left leg at the corresponding time after operation.

July 29, 1919. Massage commenced.

July 31, 1919. Patient awoke to find a small amount of dark blood had escaped from one of the stitches which has apparently healed. Several c.c. of old blood was squeezed out. Iodoform drain inserted. Pocket is at least 2.5 cms. deep.

August 2, 1919. Considerable amount of old blood and necrotic material was expressed today. Massage discontinued.

August 7, 1919. Sinus completely healed. Patient took a few steps unaided in any way.

August 16, 1919. Walks gradually.

August 23, 1919. Patient has only 25 degrees of active extension on the right leg, 10 degrees less than full passive extension. 70 degrees of flexion, no pain. Patient is improving under massage and manipulation. To continue with this. May be discharged.

DISCUSSION.

Special points of interest in this patient: On the left leg, which was rather the better of the two, there was a great deal of difficulty in bringing the knee down to a flexed position, and this difficulty was due to contractures of the capsule. However, there was a quick return to function, and the patient reports at this time a very good, satisfactory leg, with 110 degrees of motion.

The right leg—operation June 30th. Here, the scars and adhesions between the thigh and quadriceps group were so great that it was only with extreme difficulty that we were able to detach them from the bone. The tendons had to be freed at the lateral borders of the vasti and brought anterior. A large piece of fat was placed under the newly

sutured tendon, and a great deal of resistance was met with in the capsule. Adhesions about the anterior thigh were so great, and the tension of the skin so marked, as to interfere with circulation. It was necessary to make linear incisions either side of the patella to relieve the tension when the knee was flexed at an angle of eighty degrees. The post-operative notes will show the marked ecchymosis which occurred with a slight rise of temperature. The patient went on to an uneventful recovery, with rather a slower return to power than in the former operation. A few months after the operation he was able to walk up and down stairs, foot over foot, as a normal individual. He now swims and leads an athletic life, having well over 100 degrees of motion in both legs.

This was, in my opinion, a severe test case for this operation, for this case presented contraction of the muscles from long immobilization, dense adhesions from primary plating operation and suppuration, and from operation for the removal of plate and freeing of adhesions. The incision of the latter extended from the middle third of the thigh over the external condyle and across the patellar tendon.

This may seem a great deal of detail in history, but a careful perusal of such detail will answer questions that have been asked on many occasions.

Case No. 5. Age 24. White male. S. M. Admitted to Johns Hopkins Hospital October 15, 1919. Discharged November 30, 1919.

Complaint: Stiff knee.

Family History: Unimportant.

Past History: Unimportant.

Present Illness: On June 25th, 1915, patient fractured the left thigh in an automobile accident. The fracture was about six inches above the level of the knee. Patient did not know whether it was compound or not. Was taken to a hospital shortly after accident, traction was applied for three weeks, and then an open reduction was done, in which both fragments were plated. Limb was put up in full extension at the knee in a plaster cast. Six months after this all immobilizing agencies were removed and massage and manipulation were begun. At first manipulation was mild in character, but later more violent. Knee did not yield to treatment. About the middle of October of 1916, an operation was again performed in which the bone plates were removed in the hope that the adhesions which had formed around them would be sufficiently relieved to permit flexion at the knee. This operation, however, was of no avail. With the exception of mild manipulation by the patient himself, nothing was done after this until January 25th, 1918. At this time an operation was performed by Major —— at the Walter Reed Hospital at Washing-


Case 5. S. M. Movement in knee before operation.

ton, D. C., the operation consisting of an attempt to relieve the adhesions which had formed about the fracture and the removal of some of the extensive callus which had formed about the point of union. After this operation, the patient was again put in plaster for about one month. After this, manipulation was again attempted, with the result that about five or ten degrees of motion were obtained. Subsequent to this, patient went about with his knee practically stiff. No further attempts at correction were made. It is noteworthy that following the operation of January, 1918, the thigh wound became infected, with subsequent irrigations with Dakin's solution over a period of several days. Patient comes in for operative correction of the deformity.

Physical Examination: All extremities, bones and joints, are negative, except for the left leg, upon which all interest centers. The left leg shows an apparent shortening, with some slight atrophy and a scar above the knee on the outer side. At full extension the knee looks almost normal, although there is not the usual hollow above the knee in front. The patella is freely movable. All muscles seem to be in good tone, both thigh and calf. On motion, flexion at the knee is possible only 20 degrees, when

the tendon tension prevents further extension. There does not seem to be any bony ankylosis or any bone change in the joint. Above the knee at the scar level and at the seat of the old fracture there is a bony increase in width, almost twice normal. The quadriceps tendon is tied to the scar in one small area. No pain on motion. Flexion beyond 20 degrees is impossible even with force.

Operative Note: October 23, 1919. Lengthening of quadriceps tendon on left side for partial ankylosis of the knee joint. Iodine skin technique, patient in supine position on table permitting flexion of the knee joint.

A longitudinal incision was made over the middle of the anterior aspect of the left thigh, reaching from above the middle to about the middle of the patella. Skin was dissected up from either side with the subcutaneous fascia so as to expose the quadriceps tendon below. The rectus femoris and the internal and external vastus muscles were laid clear, together with the insertion into the upper end of the patella. Flexion of the knee joint then showed clearly that the restricting bands were in the region of the vastus externus. An incision, therefore, was made from the outer border of the patella upward along the line of insertion of the vastus externus into the rectus, so as to separate the patella from the restricting fibres. Mild efforts at manipulation of the knee joint then

Case 5. S. M. Movement in knee before operation.

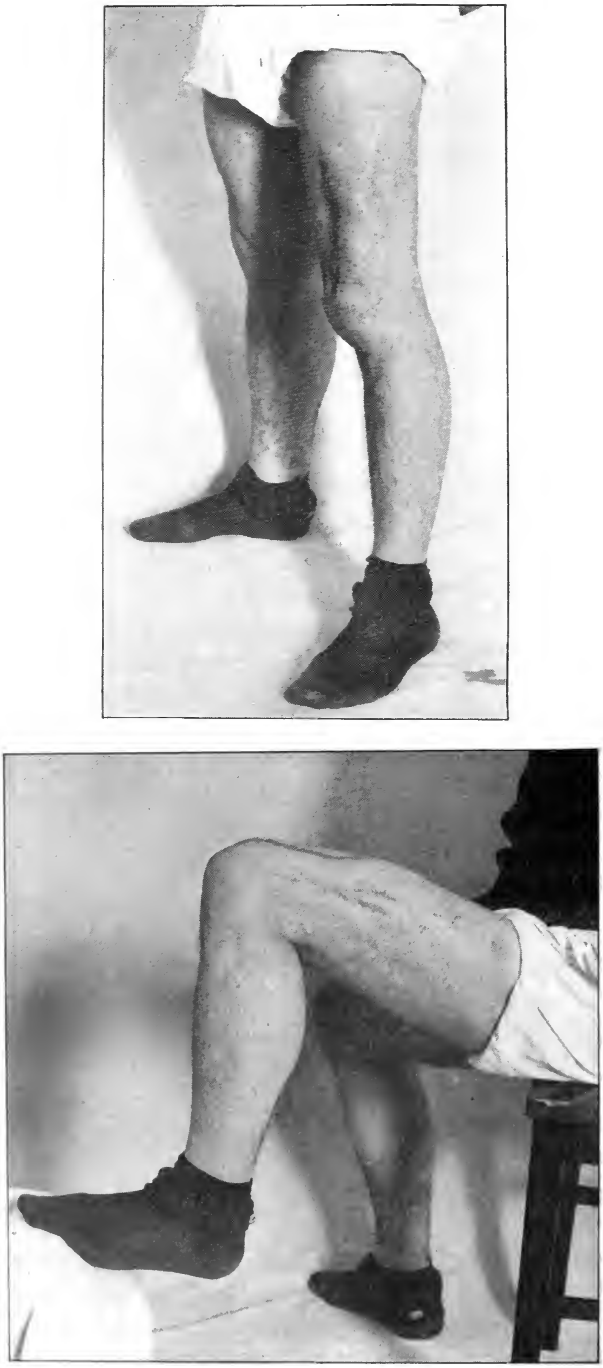
showed considerable resistance to flexion on account of contracture of the rectus femoris and vastus internus, though some relaxation was obtained. The incision, therefore, was made on the inner aspect of the patella, running upward along the course of the insertion of the internus to the rectus, incision running up the attachment of the tendon to the muscular portion of the muscle. A transverse incision then connected the blind ends of the lateral and median incision lines. The distal portion of the rectus femoris was dissected up from the bone beneath it and reflected back. Flexion was then made and the knee brought through an angle of somewhat more than a right angle. The first efforts at flexion after the muscle had been cut loose were met with considerable resistance,

Case 5. S. M. Forced flexion before operation.

apparently due to internal capsular adhesions. These were broken as the knee was bent, and the upper portion of the capsule, which was tacked down to the femur, seemed definitely to pull loose from the bone beneath it. Apparently, therefore, the entire limitation of motion could not be blamed upon the muscular tissue, although the muscular tissues had brought about the greater element.

The knee was then put up in flexion of 90 degrees, the quadriceps tendon was sewed as high up as possible with this angle to the vastus internus by means of kangaroo tendon. The tendon was then allowed to resume the place it had held naturally, and the lateral border of it sewed to the vastus externus, likewise with kangaroo tendon. A gap of about

Case 5. S. M. Extension before operation.



Case 5. S. M. End result.

one inch was left between the upper end of the tendon and the lower end of the rectus muscle from which it had been severed. Efforts were made to occlude this gap by drawing down the muscle tissues of the rectus and by pulling together the vastus externus and internus. The subcutaneous tissues were then closed with plain catgut sutures and the skin closed with sutures of fine silk. A plaster cast was then applied from groin to toes with the knee in 90 degrees of flexion. Patient lost but little blood and stood the operation very well.

DISCUSSION.

The point of particular interest in this case is the duration from the time of original injury, June 25th, 1915, to time of operation, October 23rd, 1919. Patient had a few degrees of painless motion. Leg had been functioning for approximately three years. Some capsular resistance was met with, but not as marked as in cases three and four. Patient developed a post-operative infection, probably due to the lighting of a latent infection from former operation. The quadriceps tendon behaved very much as one would expect of a mildly infected tendon. Patient went on to an uneventful recovery, and at the time of leaving our care had well over 90 degrees of motion, and was able to walk up and down stairs four months after operation. Since that time, motion has increased to extent shown in illustration.

Case No. 6. H. W. G. Age 38. White male. Admitted to Johns Hopkins Hospital October 14th, 1919. Discharged December 9th, 1919.

Family History: Unimportant.

Previous History: Unimportant.

Present Illness: In an automobile accident April 26th, 1917, sustained a compound fracture of the right and left leg below the knee (lower third of the tibia and fibula). June 9th, 1917, had operation to clear up infection and adjust fractures. Several small detached pieces of bone removed. Following this the leg improved, but had second operation January 1, 1918, for removal of sequestrum on right leg. This leg has had ulcerations on several occasions since. Was able to be up and began to walk with knees stiff about August, 1918, assisted with crutches. Since this has had massage, etc.

Physical Examination: Patient has a marked bowing outward of both legs. This is particularly pronounced on the left side. The bowing is found chiefly below the knee. On the left side, the joint permits of about fifteen degrees of flexion, has full extension, but no hyperextension. No abnormal lateral mobility. The extremes of the arc of motion do not

seem to be caused by any bone limitation. Palpation of the knee joint produces no pain, nor is there any thickening of the synovial membrane. The patella slides freely over the joint surface. There is no increase in joint fluid. The bones of the leg are apparently firmly united in the position of varus deformity, the skin over the point of fracture being well healed.

On the right side there is a similar picture with the following exceptions: 45 degrees of flexion is permitted and the bowing is less marked. Over the middle of the tibia there is a small sinus from which a drop or two of pus exudes. X-ray examinations of both knees are negative.

Impression: Contracture of the peri-articular structures of the knees, as a result of abnormally long fixation of the knee joints in full extension.

Operative Note: October 15, 1919. Lengthening of the quadriceps tendon for contraction with immobilization of the knee joint, left.

Iodine skin technique. A longitudinal incision was made on the anterior aspect of the left thigh from about its middle to the middle of the

Case 6. H. W. G. Flexion before operation.

patella below. The incision was deepened to expose the rectus femoris muscle. Later dissection then facilitated an examination of the vastus internus and externus. The knee was flexed to its maximum, and the effect of this flexion was noted on the various branches of the quadriceps muscle. Apparently the chief restricting factor was the rectus femoris. An incision was then made transverse to the rectus femoris tendon, just at its point of insertion into the patella, cutting the tendon in its entire width. Longitudinal incisions were then made from either end of this transverse section along the course of the rectus tendon at the point of insertion of the vasti into this tendon. The incision was carried up on the thigh for a distance of about four inches. Forcible flexion then permitted an angle of 90 degrees to be obtained. The flexion was rather difficult to obtain, apparently due to adhesions in the knee joint and contraction of the inner band of the vastus externus. To relieve some of the

Case 6. H. W. G. Extension before operation.

tension when the knee was flexed at right angles, the fibres of this restricting band of the vastus externus muscle were cut transversely at the proximal portion of the incision made previously. With the knee flexed at a right angle, there was a gap left between the insertion of the patellar tendon and the distal cut portion of about two inches. To cover this gap the border of the vastus internus and externus, which had been cut, were sewed together so as to practically obliterate the space left by the retraction of the femoris. The rectus femoris in its new position was sewed to either side of the muscle tissue, the entire incision line being joined to the adjoining muscle with kangaroo tendon. The fascia was then sewed over this by means of chromic catgut, the subcutaneous plain catgut suture line was inserted, and a long continuous lockstitch silk suture completed the closure of the skin.

Post-operative Note: Plaster was removed at the end of three weeks. Patient had an uneventful post-operative recovery. Massage was insti-

Case 6. H. W. G. Forced flexion before operation.

tuted in the fourth week. Patient was discharged on December 9th with 60 degrees of painless motion, which has increased to 90 degrees since.

DISCUSSION.

This case shows a true contraction of the muscles of the anterior thigh, due to long immobilization in full extension for a lesion below the knee.

CASE No. 7. A. L. Age 21. White male. Operated on at Ruptured & Crippled Hospital, New York, December 30, 1919.

Family History: Unimportant.

Past History: Pneumonia when two years old. Diphtheria when eight years old. Following diphtheria, patient developed pain in right thigh, which continued for ten weeks, when it subsided, not to return until a lapse of one year. Then a growth developed on the inner aspect of the thigh at its highest point. This growth was about the size of an orange.

Case 6. H. W. G. Extension before operation.

After a year this tumor ruptured and drained for a whole year. In 1911 patient was operated on and about forty-five pieces of splintered bone were removed. Six weeks later was discharged from the hospital. Two weeks after discharge from hospital developed pleuro-pneumonia, which proved severe. Was sick for six weeks. In 1912, a year after operation, there was a discharge at the site of tumor. Since then there has been no return of symptoms in thigh.

Present Illness: On October 26th, 1918, without apparent cause, patient had pain in right knee and leg was fixed in flexion. Was treated first as rheumatism. Later condition was diagnosed as septic arthritis, and treated by application of plaster cast and extension for three months. This treatment failed to give the desired results and pain and stiffness remained. Nothing has been done since, but patient is better able to

Case 6. H. W. G. Flexion after operation.

Case 7. A. L. X-ray taken before operation.

get around, having to avoid sudden jars or becoming fatigued. Is now admitted for forcible correction under anesthesia.

Physical Examination: Patient admitted without apparatus, walking with a stiff knee on the right side.

R. A., 38¼. R. T., 16½. R. K., 13¼, 13⅝, 12¾. L. A., 38¼. L. T., 20½. L. K., 14, 14, 12⅞. R. C., 12½. L. C., 12¾.

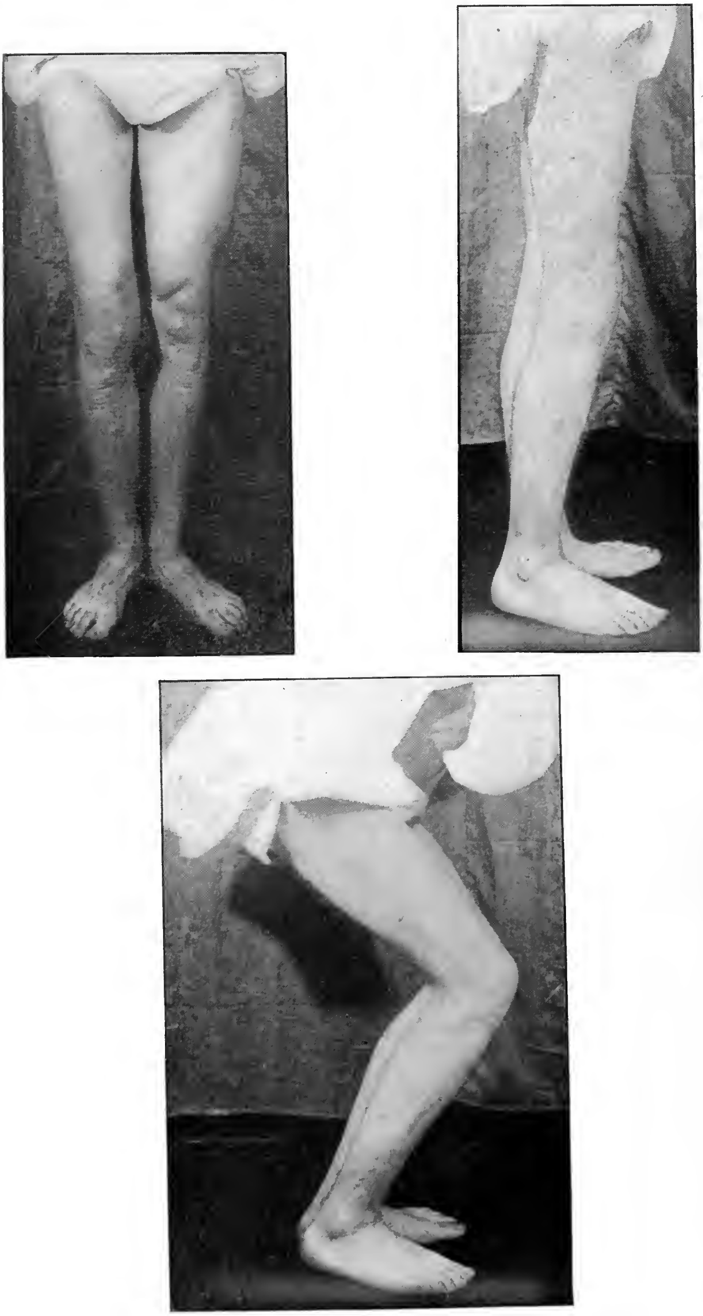
Moderate infiltration about the right knee joint, most marked in the subcrural pouch about the patella. The patella is slightly movable.

A. G. F., 165.

A. G. F., 160.

With this amount of motion there is no pain or muscle spasm. The limitation seems to be a mechanical block. The x-ray picture shows thinning of the cartilage and general rarefaction of the bones. Slight thickening, more marked on the inner side of the head of the tibia and condyles of the femur. No erosion of the joint surfaces.

Operative Note: November 10, 1919, manipulation under anesthesia. Thirty degrees of motion obtained followed by considerable joint reaction.



Case 7. A. L. End result.

DISCUSSION.

On December 29, 1919, patient was examined by the author and was not thought to be a suitable case for operation, as it was the author's opinion that there was an active arthritis. The point was brought up by Dr. V. P. Gibney, that if contraction of the quadriceps tendon occurred from immobilization in extension from fractures, etc., the same could occur from immobilization from inflammatory lesion. In his opinion there was no active arthritis in this case.

At the request of the patient a lengthening of the quadriceps was done on December 30, 1919 (by method shown in cuts demonstrating operation). With very little effort the knee was flexed to a position of 90 degrees, after the tendon had been detached. It was the opinion of the author at this time that a violent reaction would be started in the knee by operation. So he attempted to keep on the safe side by sewing the tendon, and fixing it in a position of forty-five degrees, instead of the usually eighty degrees of flexion.

At the request of the author an early inspection of the leg was made and passive motion begun. The author was surprised to hear that only a moderate joint reaction had occurred. Under rather vigorous manipulation and post-operative treatment this patient made a good recovery, and on October 21, 1920, has approximately ninety degrees of painless motion (as shown in illustration) and walks without limp.

This case demonstrated clearly the two points made by Dr. Gibney:—that there was no active arthritis in this case, and that a contraction of the anterior thigh group is sometimes associated with immobilization from inflammatory disease of the joint, as well as from extra-articular lesions. It is the opinion of the author that the operation should not be done unless one is sure that no active inflammation is present.

Case No. 8. R. C. W. Age 30. White male. Admitted to Johns Hopkins Hospital, January 8, 1920. Discharged April 6, 1920.

Family History: Unimportant.

Past History: Unimportant.

Present Illness: October 15, 1918, was struck in the right hip with a piece of high explosive shell and sustained a fracture of the ilium and anterior hip joint. Was operated on twenty hours later and foreign bodies removed. December, 1918, operation on the right hip joint with immobilization. At this time there was no evidence of any lesion about the knee joint or foot. Leg immobilized in plaster which was removed on February 15th, with many excoriations—knee stiff and foot drop.

Thomas splint was then applied for a period of four weeks, followed by second immobilization in plaster. During this time there was considerable discharge from the hip joint. In May, 1919, several abscesses were opened down the thigh extending to a few inches above the knee. Hip joint and all draining sinuses were cleared up by July 10, 1919, leaving a painful knee joint and toe drop.

Physical Examination: Patient complains of stiff knee and hip. The right hip is absolutely ankylosed in full extension, in neither abduction or adduction, and in neutral position as far as rotation is concerned. There are numerous scars of old incisions about the hip. One of these over the front of the thigh seems to be attached to the bone at about the level of the junction of the middle and lower thirds. The knee joint is likewise in full extension, but permits of a few degrees of flexion, so as to rule out bony ankylosis. Passive flexion stops when the tissues below the scar mentioned become taut. Active efforts at extension are likewise visibly embarrassed by the attachment of the quadriceps at the scar. Palpation of the knee joint reveals considerable tenderness to pressure over the anterior portion of the internal semilunar cartilage. No abnormal lateral mobility is obtained. The patella is freely movable.

Neurological note. January 10, 1920.

Apparently the ham string muscles are active. Internal stronger than the external. Below the knee the calf muscles act strongly in extension. Can flex the ankle with fair strength. No evidence that the popliteal muscles are active. No movement of the great toe on extension. Ankle reflex active. There seems to be some numbness over the dorsum of the right foot. Nowhere is there absolute loss of sensation.

Impression: Case impresses me as a recovering pressure paralysis of the external popliteal nerve.

Operative Note: Lengthening of the quadriceps tendon for loss of motion in the right knee.

Iodine skin technique. An anterior longitudinal incision was made on the right thigh from its middle third to the knee joint, and deepened to expose the quadriceps tendon. The skin and subcutaneous layers were then dissected up to either side, so as to show the superficial component parts of the muscle at their tendinous insertions. The rectus femoris was cut transversely at its point of union with the tendon, the ends of the incision being carried down to the patella on their respective sides, in such a way as to sever the connection of the tendon from the vasti muscles. The tendinous flap was dissected up from the underlying bone to the level of the upper part of the patella. Very little force was

then needed to flex the knee joint, but in doing this the capsule, which was very adherent, was torn. After the first manipulation was made the normal movements of the knee from full extension to almost 70 degrees of flexion were obtained freely. Considerable bleeding from the capsule was encountered. The knee was held flexed 80 degrees and the patellar tendon, being drawn up as far as possible in flexed position, was resutured to the vasti with kangaroo tendon. The gap left between the upper end of the tendinous flap and the rectus femoris, about an inch long, was closed by drawing together the lateral borders and suturing them with kangaroo tendon. Subcutaneous layers were then closed with plain catgut and skin with silk. A plaster knee cast was applied with the leg in 80 degrees of flexion. The patient lost a fair amount of blood, but stood the operation well.

DISCUSSION.

The notes on this case are of particular importance, since this case marks a failure. The clinical and X-ray examinations showed definite knee joint changes, with some local reaction in the knee, at the time of operation. This young man was in such a pitiable condition, with an ankylosis of the hip, only a few degrees of motion in the knee, and an external popliteal paralysis, that an attempt was made to relieve the evident adhesions in the thigh. His post-operative findings show that we had irritated an inflamed joint, and caused marked reaction, with the result that at the present time he has 30 degrees of painful motion. In post-operative treatment he sustained a fracture through the condyles due, probably, to rather vigorous massage to a joint that had not functioned in fifteen months and was very atrophic.

I believe the reporting of this case to be as important as any of the series, and hope that perhaps the report will prevent others from attempting an operation of this type on very atrophic and actively inflamed joints.

SUMMARY.

Certain rather definite findings are to be noted. First:—contraction of the quadriceps without adhesions will produce a loss of function of the knee.

Second:—contraction and adhesion between the muscles themselves, or between muscle and bone, will produce loss of flexion of the knee.

Third:—the capsular changes are not as constant a finding as the muscular changes. Knee joints that cannot be forcibly flexed before the releasing of the tendon can be easily flexed afterwards.

Fourth:—contraction of the muscular tissue following long immobilization for inflammatory knee joint disease, probably is present, but it is not advisable to operate in the presence of a sensitive joint.

Time is an important factor. It is better to operate on a patient who has walked for five years with ten degrees of motion, than on one who has walked for five months with thirty degrees of motion. In the former, joint and muscle tissue are in good tone: therefore, they lend themselves better to operation and they return to function much more rapidly.

DESCRIPTION OF OPERATION.

Patient should be placed in a position to allow free movement of the leg, and to permit flexion to 100 degrees. This can be most easily accomplished by extending the leg over the end of the operating table.

A straight incision is made on the anterior surface of the thigh, extending from the middle of the patella to approximately the junction of the central and lower thirds of the femur, passing through the subcutaneous tissue and fascia. A lateral blunt dissection gives an exposure of the vasti, the attachment of the rectus, and the capsule of the knee joint. If adhesions are present, exposure should extend to a point at least two inches above, permitting a thorough inspection of the entire field.

When dealing with a simple contraction not associated with adhesions of the tendon and muscle to the femur, only the tendinous section is cut free from its muscular attachments. This is accomplished by a linear incision on each side of the tendon, extending from the attachment of the rectus femoris to the patella, following closely to the muscle margin, and broadening at the patella, leaving its normal strong attachment at this point. These parallel incisions should be deep enough to include the tendinous section of the vastus intermedius (crureus) (see Fig. No. I). These are connected by a short incision and the entire tendon is dissected free from the underlying structures, from the rectus to the patella (Fig. II.) With the tendon completely detached from its muscular attachments, the knee is carefully flexed, cutting any adherent points in the capsule, or about the lateral margin of the knee. Flexion is carried to a point of at least ninety degrees. The leg is then brought to a position of eighty degrees of flexion, and the tendon re-attached to its muscle at this level, as shown in Fig. III, by means of kangaroo tendon or heavy braided silk.

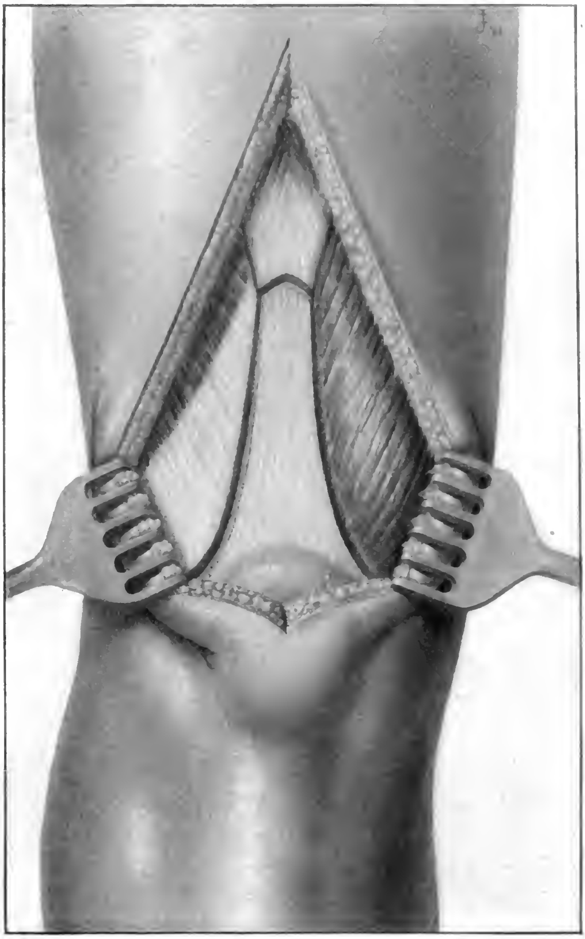


Fig. I.

In the presence of marked adhesions in the lower thigh, it may be necessary to dissect the vasti free from the femur, thus permitting them to be drawn toward the median line, and attached to the tendon. If necessary, fascia or fat can be placed between the bone and the muscular structures. With the tendon in its new position, a space is open at the lower end of the rectus (Fig. IV). This is closed by mattress suture through the vasti.

The operation as above described has been modified by attaching the muscle to the tendon at different levels, and by utilizing the tendon

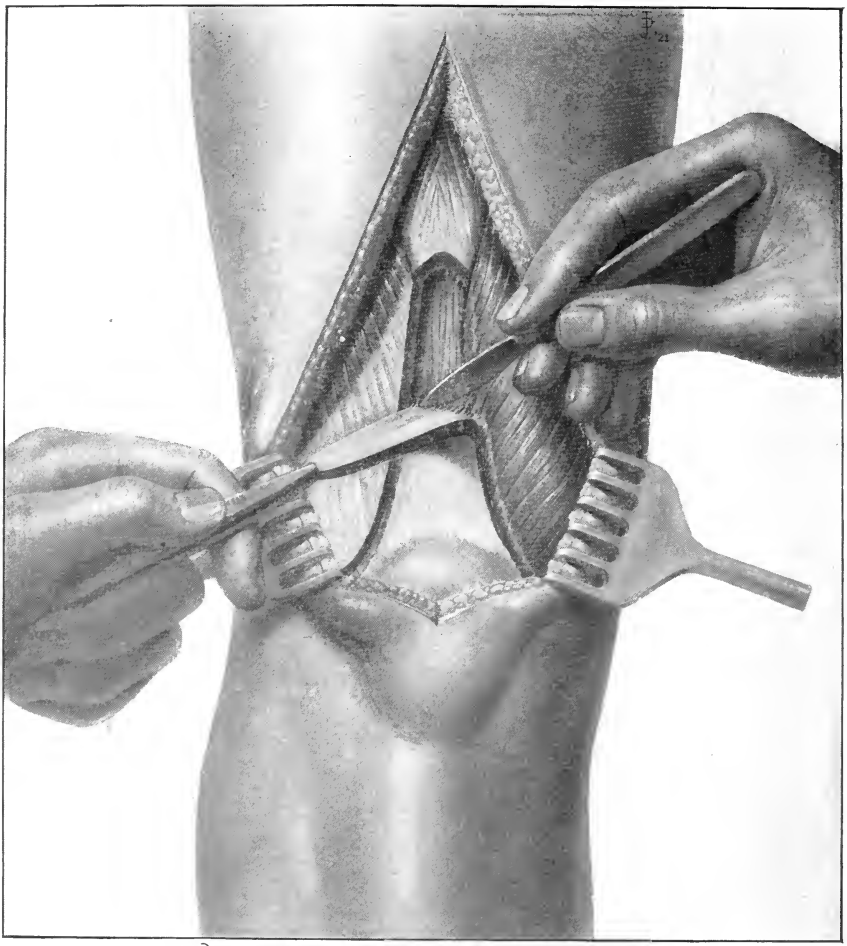


Fig. II.

fibres of the rectus to fill in the space mentioned above. But this complicates the operation and does not hasten the convalescence or improve the end result. However, occasionally one finds a rectus tendon that is independent until it reaches a point about one inch above the patella, where it becomes a part of the quadriceps. When this occurs, it is well to cut it free at its lowest point, retract, and proceed with the operation as described. After the lengthening, the rectus tendon is then attached to the quadriceps. The fasciae are closed with catgut and non-absorbable skin suture. Plaster of Paris is used to immobilize in a position of eighty degrees of flexion for a period of three weeks. The plaster dressing is

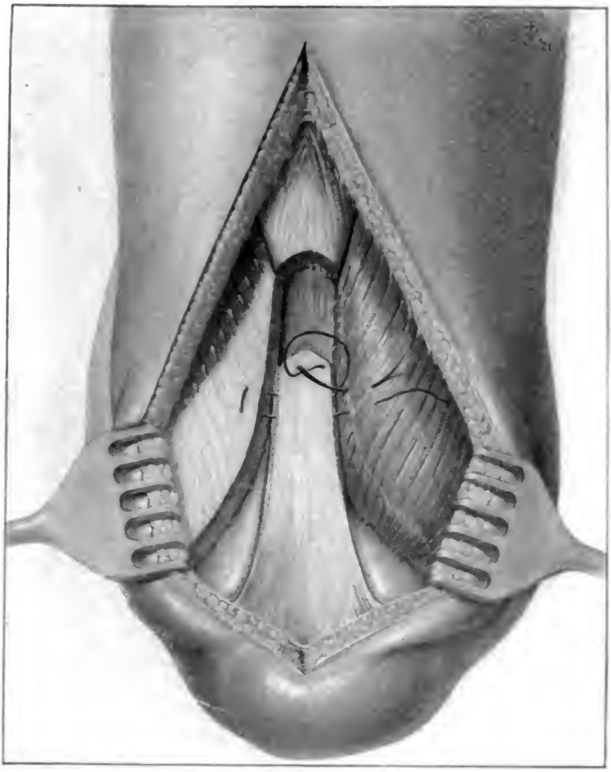


Fig. III.

then cut, removing the upper half, and passive motion is begun. Gradual passive extension of the knee is then begun during the day, and the knee is placed back in the splint in its flexed position at night. At the end of the fourth week the author encourages active contraction of the muscles with the leg held firmly in an extended position. In mild cases active use of the leg during the fifth week is advised, and the patient is encouraged to walk with crutches and bend the knee to its full extent, but not to place any weight on it. Active extension of the knee when in a standing position is also encouraged, but care should be used in the effort to extend the leg when in a sitting position. Massage is usually begun at the end of five weeks, but should be mild until all of the acute trauma has subsided.

A common post-operative finding is an extreme degree of ecchymosis on a part or the entire anterior thigh. Particularly is this true in the

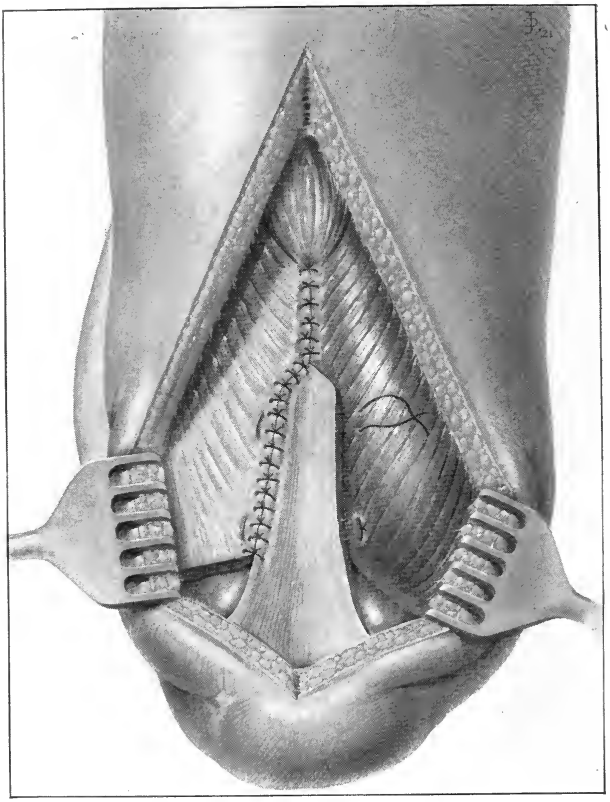


FIG. IV.

cases with adhesions as well as contraction. No skin necrosis has occurred in any of the cases.

The return of power to extend the leg to a normal position is slow, particularly the last fifteen degrees, and in some instances was not accomplished until a year after the operation. The quadriceps tendon often cannot be palpated for two or three months, but gradually fills in and becomes normal in size.

Since the writing of this paper, approximately one year ago, the author has operated on four additional cases, all of which have recovered with not less than ninety degrees of motion.

PRACTICAL THOUGHTS ON BONE PEGS, BONE SCREWS, ETC.

HARVEY C. MASLAND, M.D., PHILADELPHIA.

Recent literature relating to bone screws and bone pegs inclines me to believe that certain practical principles underlying their use have not been appreciated. There is indication that operators are having difficulty in the easy utilization of these valuable aids. Their inability to make and use pegs and screws quickly, easily, and with perfect certainty of accomplishment has delayed the recognition of the fact that pegs and screws are the logical and the best binding material we have in the vast majority of cases for plastic bone work.

In my experiments in the cutting of small-diametered pins I quickly found that the high speed universal motors burned and burnished all the pins made. The dowelling tools commonly used have numerous shallow cutters. These quickly choke, then chafe, with the result that seventy-five per cent. of the bone pins are broken in the making.

I substitute a low speed selective current motor. Instead of the fourteen cutters on the dowelling tool I use three. This combination will cut a bone cylinder one and a half inches long in a few seconds with no heat, binding, or breaking.

In the making of bone screws the gauge of the tools that are correct in a machine shop for metal is worthless. It is not practical to attempt to cut on bone as deep and clean a thread as can be made on iron. Unless such a thread be cut in successive stages the bone will inevitably break. Further, such a screw is difficult to turn into a threaded bone hole without binding and breaking. I made my dowelling tool of such a gauge that the die will cut a sufficiently deep thread by hand. By hand this screw can be turned into a threaded hole and have sufficient bite to hold rigidly for all practical purposes. The head of the screw is nothing but the rough uncut end of the bone pin. With the fingers or a hemostat it can be handled both in its manufacture and its use. One bone screw one and a half or one and three-quarter inches long is sufficient for four holes. It is turned through the compact layers of the first holes, cut off flush and so utilized for the remaining holes.

There are certain underlying principles that should decide us as to whether bone screws or bone pins should be used. It might be put in the form of a general statement that where the strain is along the line of insertion a bone screw should be used. Where the strain comes at an

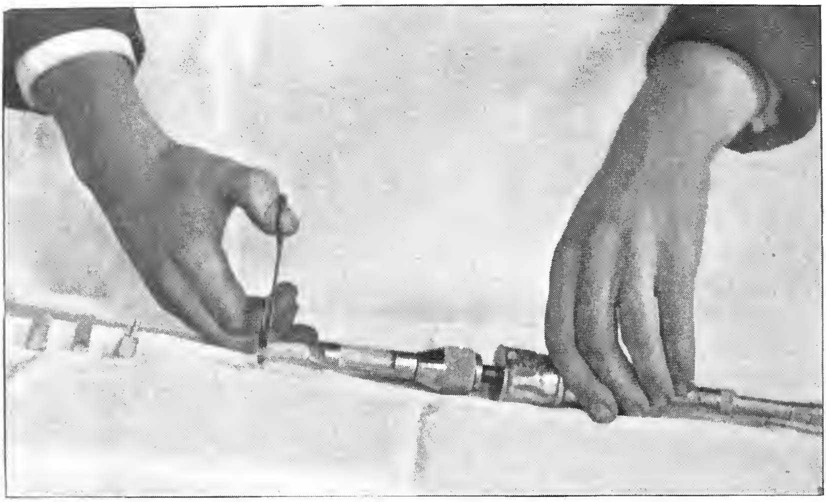


Fig. 1.—The point of the bone strip placed in the bore of the dowelling tool. Start the point right to make a true cylinder.

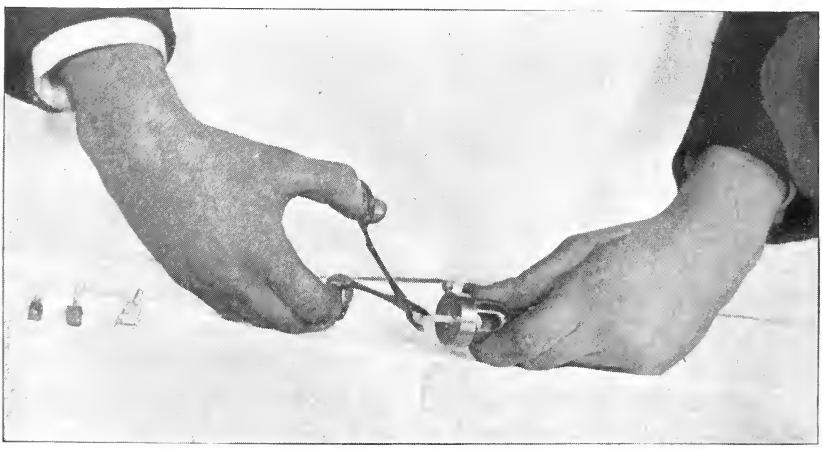


Fig. 2.—Cutting a thread on a bone pin. Fresh bone is less likely to chip.

angle a bone pin is most practical. Where a bone plate is applied after the Lane method bone screws should be used. In a bevelled slide graft, however, the drill should be directed to catch the margin of the graft and penetrate the compact bone of the shaft to be plated at a transverse

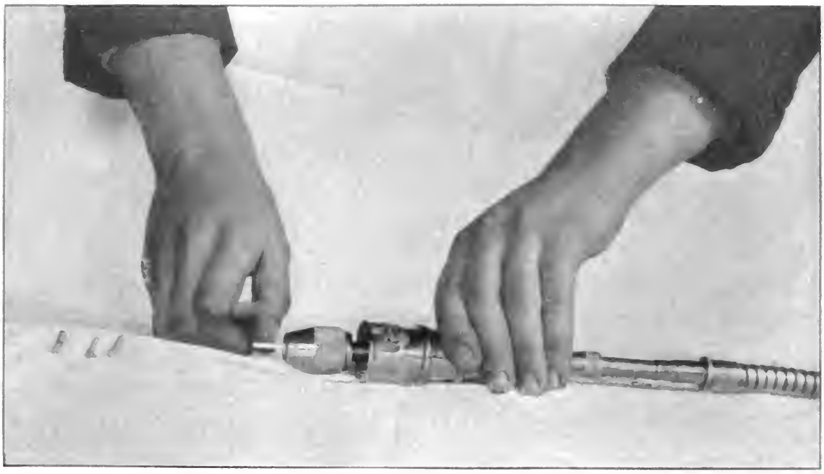


FIG. 3.—The bone pin is engaged in the chuck tool and can be filed down to any desired diameter.

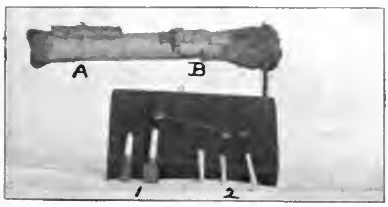


FIG. 4.—A, Bone plate and bone screws holding fracture. B, Slide graft with appropriately reduced bone pins obliquely placed at the margins of the graft. 1, bone screws. 2, bone pins.

oblique angle. The bone pin need be just a snug fit under such conditions. Pressed into place by hand the cross strain against it will hold it and the graft in place.

The dowelling tool in my equipment makes a pin that allows for a thread and would, therefore, be too large for the drill that makes a hole requiring a mating thread. To make the pins fit the hole made by the drill the bone pin is fitted into the chuck tool and while rotated by the motor is filed down to the diameter desired.

This ability to turn the bone pins down to any smaller diameter is valuable where we have the smaller bones of the limbs to operate upon. One would not use the same size bone pins in plating an ulna that he would use for a femur.

In the tool holder which I use, drills, taps and dies of varying diameters can be procured from the nearest hardware store. These unnickelled tools are really superior cutters in that their edges have not been dulled by the deposit of nickel. Quick drying and oiling is all that the unnickelled tool needs to preserve it a better instrument. I would emphasize here the necessity of requiring of the nurse proper after care of bone instruments. Some of the tools are expensive. Incomplete drying and oiling will in a short time damage an instrument that should last indefinitely.

The objection will be raised that this class of bone work is nice theoretically but is not practical. This is because we have not submitted ourselves to learn the practical way. It is surprising how quickly these things can be done at the operating table with a proper equipment and the acquisition of the necessary technique. In this connection, however, I feel that the making of bone pins or screws at the time of operation is quite unnecessary. I look upon bone pins and screws solely in the light of suture material. There is no valid reason why they cannot be heterogenous. One can make a supply of beef bone screws and pins of varying diameters and threads at his leisure. This is a saving of time and of autogenous bone. These can be cleaned, boiled, and kept sterile until needed.

Finally, the different power equipments now supplied offer varying degrees of facility in operation, but none of them should be used till the operator learns how to use them. Those who are willing to learn how to use and how to care for these modern equipments will be amply repaid in the increased facility at operation and the quality of the work performed.

THE STANDARD PLASTER BANDAGE.

BY WILTON H. ROBINSON, M.D., PITTSBURGH.

WHEN applying a plaster cast one wishes it to look well and to be efficient. With other minor considerations, it should be of an even thickness throughout (except at those places where it is reinforced) and all layers should cohere closely. It is difficult to obtain these two most important considerations unless the bandages are properly made. It seems to the writer that a very important factor in consistent plaster work is uniformity of the bandages used. This uniformity may be obtained and maintained by the occasional use of a scale to weigh the completed bandages. It is not necessary to weigh each bandage, as the person doing this work easily becomes familiar with the standard bandage in each size. Any scale which has a capacity of from one to sixteen ounces will do.

The following table of lengths and weights has been found satisfactory:—

Two inches wide by one yard long should weigh two ounces.

Four inches wide by four yards long should weigh eight ounces.

Six inches wide by four yards long should weigh ten ounces.

Each bandage is wrapped in a paper napkin, except the two-inch size, for which one-quarter napkin is sufficient.

A CASE OF SPONTANEOUS FRACTURE OF THE TRANSVERSE PROCESS OF A LUMBAR VERTEBRA—DUE TO TUBERCULOSIS.

BY BEVERIDGE H. MOORE, M.D., CHICAGO, ILLINOIS.

The following case presents unusual features which seem to justify reporting it.

H. McC., negro, male, aged 27 years, was first seen at the Orthopedic Clinic at Northwestern University Medical School, on November 29, 1920. His complaint was pain in the left thigh and lumbar region. It had come on suddenly about four months previously while he was doing some light work at a grinding machine. There had been no unusual strain nor could he recall any trauma.

The pain at the onset was so severe that he was unable to stand or walk, but this severe pain gradually left, and was replaced by a dull aching pain which had persisted. A few weeks after the onset, he noticed that the left thigh and leg were becoming weaker than the right, and he thought they were "falling off" in size.

The pain complained of radiated down the inner side of the thigh to the knee. Walking or stooping caused severe pain to shoot down the thigh.

The family history and previous history were unimportant. He had lost some weight but had had no night sweats or cough.

Examination showed a muscular young negro.

The spine showed the normal antero-posterior curves. In the left lumbar muscles there was a swelling near the spinous processes, which gave deep fluctuation but was only slightly tender. There was no local heat. No spasm of these muscles was present.

The entire spine showed a slight list to the right.

Forward, backward, and lateral bending all caused severe pain which radiated down the thigh. Lateral bending to the right caused specially severe pain.

Both hips and knees showed normal motion, passively. Active flexion of the left hip, especially against some resistance, caused severe pain both in the back and the thigh.

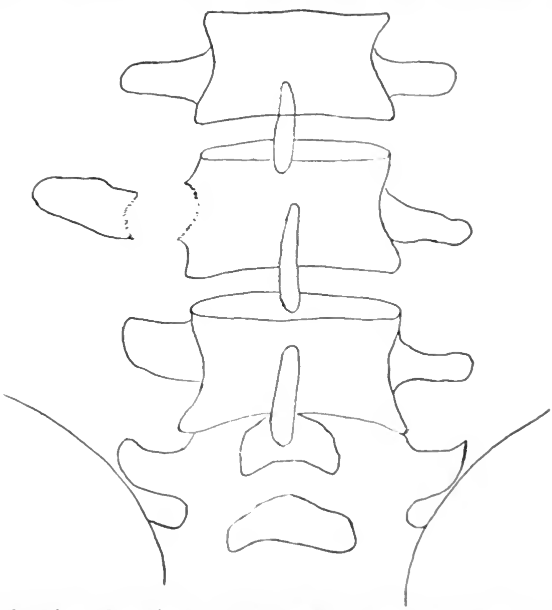
The left thigh was one inch smaller than the right and the calf was ¾ inch smaller than the right. There was decidedly less strength in the muscles of the left thigh and leg.

X-ray showed the entire transverse process on the left side of the third lumbar vertebra separated from the vertebral body and lying about 1 cm. from it. The bodies of the vertebrae and the intervertebral discs appeared entirely normal.

The patient was referred to Cook County Hospital, where he was admitted to the Orthopedic Service on December 8, 1920.

The swelling in the lumbar region had increased somewhat in size and was more fluctuant. It was aspirated and a thin grayish pus

Showing abscess pointing in left lumbar region, and atrophy of left thigh.



X-ray tracing showing detached transverse process of third lumbar vertebra.

containing flocculent material was removed. This was sterile on culture, and a guinea-pig was inoculated.

The abscess was opened and drained. The transverse process was found lying free in the abscess cavity and was removed.

The appearance of the pus in the abscess cavity was typically tuberculous.

After the removal of the bone fragment and the evacuation of the abscess the leg pains ceased. A sinus opened in about three weeks which drained profusely.

Later the patient began to lose weight and developed signs of a generalized miliary tuberculosis.

He died on March 31, 1921.

Autopsy was performed by Dr. D. J. Davis, on April 5, 1921.

There was a marked miliary tuberculosis of practically all the internal organs. The lungs, liver, spleen, adrenals, kidneys, pancreas, peritoneum, and brain showed miliary tubercles and caseous nodules.

The bodies of the third and fourth lumbar vertebræ showed considerable necrosis, and appeared to be full of minute foci which had not yet coalesced. The first and second vertebrae showed the same process but in a less advanced stage.

The sinus in the lumbar region was characteristically tuberculous, with its base at the root of the affected transverse process.

Sections of the bone were characteristic of tuberculosis.

It seems fair to conclude that the primary bone focus in this case was in the transverse process, since this lesion was much more advanced than the process in the vertebral bodies.

The weakened process probably gave way under some slight muscular strain.

Tubby, in his book on "Deformities," speaks of the transverse processes being a rare location of the tuberculous process but he does not cite any cases.

Speed, in his book on "Fractures," cites several cases of fracture of the transverse processes. These were all, except one, due to muscular action, but no mention of any previous pathological process in the bone is made.

The symptoms are easily accounted for on an anatomical basis.

The radiation of the pain to the thigh and knee is due to pressure either of the fragment or of the abscess on the obturator nerve, which takes its principal origin from the third lumbar nerve.

The pain on flexion of the hip is probably due to the action of the psoas muscle, which has one origin from the transverse processes of the lumbar vertebrae.

While rare, tuberculosis is a condition to be considered in fractures of the transverse processes. Aspiration, in the cases which show fluctuation, is useful in differentiating between hematoma and abscess.

SUBASTRAGALOID EXTERNAL DISLOCATION.

BY ELLIS JONES, M.D., LOS ANGELES, CALIFORNIA.

LATERAL subastragaloid luxations of the foot to the outer side are not common. A review of the literature indicates that their pathological anatomy has been reconstructed for the most part on the basis of the clinical findings, and it is not surprising, therefore, that the mechanism of this displacement is disputed and the causes of its irreducible behavior are variously explained.

Recent textbooks on fractures and dislocations make bare mention of the subject. To Verneuil,[1] Poinsot,[2] Quénu,[3] Broca,[4] Malgaigne,[5] Nélaton,[6] Cowell,[7] Kaufmann,[8] Deetz,[9] Thienhaus,[10] and Lossen[11] the student is referred for modern light on an ancient subject. Quénu ascribed a failure of reduction to the interposition of an intact annular ligament between the articular cavity and the head of the astragalus. Cowell explained the mechanism of the dislocation as being identical with the ordinary Pott's fracture. Pick[12] ascribed the difficulty of reduction to displacement of one or the other of the tibial tendons behind the neck of the astragalus.

Broca and Poinsot collected twenty-three simple cases of all types of subastragaloid dislocations in which reduction was attempted. Reduction was successfully accomplished in fourteen, and the ultimate result was good; in two, the reduction was incomplete, and one of these died of septicaemia. There were four secondary amputations with three deaths, three secondary removals of the astragalus with one death, and one good functional result, notwithstanding the persistence of the deformity.

In seven additional cases in which reduction was not attempted, four of the patients had apparently good function. In one case reduction was made after six months; in two cases the disability was such that the patient sought relief; Sinnigen[13] removed the astragalus and external malleolus, and at the time of the report death by septicaemia was expected; Raffa[14] chiselled away the head and the neck of the astragalus and was then able to straighten the foot; recovery without suppuration; good result.

In two cases primary excision of the astragalus was done with good results. In Verneuil's there was fracture of the astragalus and rupture of the peroneal artery; in Oré's[15] an attempt to reduce had failed and gangrene of the tense skin was imminent.

Of compound dislocations seventeen cases were collected by Broca and six additional by Poinsot in 1884; and to these, two cases reported by Jackson[16] and Stimson[17] are to be added. Of these, reduction was

made in eleven, with two deaths, with persistent suppuration in two, and with secondary removal of the astragalus in one. In fourteen reduction was not made; in three of these primary amputation was done, in ten, removal of the astragalus, with two deaths, and in one the head of the astragalus became necrosed and was spontaneously extruded, the patient recovering. The results of primary removal of the astragalus are rather better than those of reduction, but the value of these statistics as a basis for the choice of a method of treatment has been greatly diminished, as Stimson suggests, by the improvement in the methods of treatment of open wounds that has taken place in the last few years.

More recently (1913) Viannay[18] and Fayard[19] observed two cases of subastragaloid luxation of the foot outward. In the first case an astragalectomy was required on account of the irreducible character of the lesion. In the other case reduction was obtained on the day of the accident by manipulation so planned as to first exaggerate the luxation by hyper-abduction and a reduction by sudden forcible adduction of the foot.

The above statistics emphasize the seriousness of the lesion and the need of early reduction and appropriate treatment in this type of dislocation.

The forms known as dislocations backward, inward, and outward of the os calcis and scaphoid from the astragalus were recognized in Broca's plan of sub-division. Malgaigne added a fourth variety, dislocations forward. The dislocation thus presents four varieties, occurring at the astragalo-scaphoid and astragalo-calcaneoid joints: displacement of the os calcis and scaphoid inward and somewhat backward, with the head of the astragalus projecting on the outer part of the dorsum of the foot, their displacement directly forward or backward and downward and finally their displacement outward. The occurrences of the first two varieties, while uncommon, are of equal frequency and comprise the greater number of cases. The last two varieties are of less frequent occurrence.

Two varieties of the dislocation outward have been described clinically by Malgaigne, distinguished by marked abduction of the toes in one and its absence in the other. It is possible that such a clinical distinction is based upon the degree of the dislocation itself rather than indicating a distinct variety.

Recent opportunity for a study of the mechanism, pathological anatomy, clinical and radiographic findings, was afforded the writer in the study of the following case of subastragaloid external dislocation complicated by fracture of the neck of the astragalus.

PLATE 1.—Subastragaloid external dislocation with comminuted fracture of neck of astragalus.

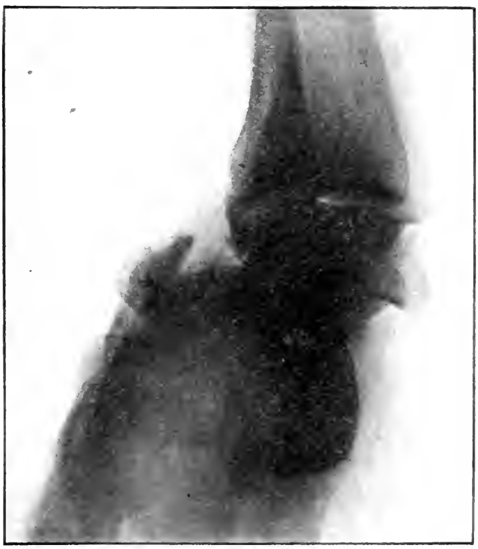


PLATE 2.—Subastragaloid external dislocation with comminuted fracture of neck of astragalus.

PLATE 3.—Subastragaloid external dislocation after reduction.

J. T., male, aged 39. Examination, October 6, 1920, three days after accident. Patient had fallen sixty feet into arroyo, striking on left foot. The local physician had attempted reduction, believing the injury a Pott's fracture. The foot was in extreme valgus with the concavity of the sole obliterated and a well-marked depression admitting three finger tips under the internal malleolus where the edge of the inferior margin of the body of the astragalus was easily palpable. The relation of the body of the astragalus to the internal malleolus was unchanged and this sign, together with the extreme valgus, was sufficient for the clinical diagnosis of external subastragaloid luxation. The skin over the head of the astragalus was taut and ecchymotic and lacerated where the patient had attempted with pocket-knife incisions to relieve the pain of internal bleeding. Beneath the skin, over the front of the ankle joint, was a firm, hard tumor, presumably the head of the astragalus. Flexion and extension were demonstrable at the ankle, but the foot was held in rigid equino valgus. Stereoscopic radiographs (Plates 1 and 2) confirmed the diagnosis. Reduction was easily obtained, after a tenotomy of the tendo Achillis, by direct skeletal traction with a Steinmann pin through the tubercle of the os calcis (Plate 3). The comminuted fragments of the head and neck of the astragalus were excised through an anterior incision. The astragalo-scaphoid ligament was found intact. Carrel-Dakin tubes were introduced and the patient given an immunizing dose of tetanus antitoxin.

PLATE 4.—Astragalectomy following external subastragaloid dislocation.

On the third day, because of extending infection, a curved incision was made over the internal malleolus and extending to the base of the internal cuneiform bone. A four-inch external incision was made similarly from the external malleolus to the head of the fifth metatarsal and Dakin tubes placed. Culture showed streptococcus haemolyticus in almost pure culture. The convalescence was stormy and the temperature ranged from 97 to 105. At no time was a sterile count obtained and the radiographs showing an increasing necrosis of the astragalus, an astragalectomy was done on November 29th. Thereafter, convalescence was relatively uneventful, and a sterile bacteria count was obtained on the eighteenth post-operative day. A transfusion was done because of a haemoglobin of 38% and red cells of 3,200,000. No attempt at wound closure was made and on January 10th all wounds were healed and Bristow coil work and physiotherapy were begun. Five months after the original injury and four months after the astragalectomy, the

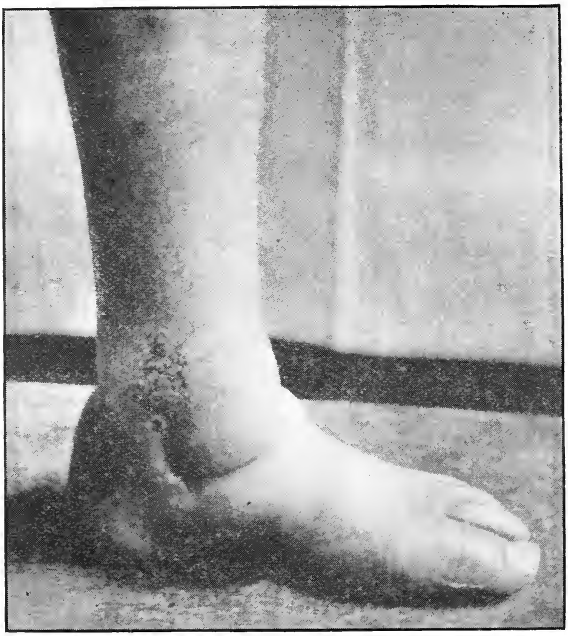


PLATE 5.—End-result after astragalectomy.

PLATE 6.—End-result after astragalectomy.

patient walks with a cane and slight limp, with function increasing and with 25° of motion in the ankle joint (Plate 4).

Astragalectomy furnished little opportunity for study of the lesions complicating the dislocation. The extensor and peroneal tendons were in their proper places. The internal lateral ligament and the anterior annular ligament were intact. It is difficult to conceive how either the extensor or peroneal tendons could act as obstacles to reduction.

In experiments on the cadaver the writer was able to reproduce subastragaloid external luxations in the following manner. The foot was placed in strong pronation. In this position the astragalus butts against the post-surface of the anterior process of the os calcis, the joint gaping inwards. The astragalus is now enabled to move or luxate over the os calcis and from the hollow of the scaphoid inwards. An increase in the forced pronation, together with forcible eversion of the os calcis, completes the dislocation. It was possible to obtain fracture of the neck of the astragalus (as in the writer's case) only by direct violence while forced and rigid pronation was being maintained.

A few practical conclusions seem justified:

The mechanism of external subastragaloid dislocation is that of strong pronation with eversion.

Apparently, tenotomy of the tendo Achillis facilitates reduction of a subastragaloid external dislocation and permits easy lateral replacement of the dislocated os calcis. Traction on the os calcis should be accompanied by strong supination of the fore foot.

In a compound fracture-dislocation, early astragalectomy should be considered because of the almost inevitable necrosis of the astragalus.

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HYPERTROPHIC BONE CHANGES IN TUBERCULOUS SPONDYLITIS.

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TUBERCULOUS osteitis has generally been considered a destructive pathologic process producing a carious degeneration with little or no tendency toward bone regeneration during the acute or active stage of the disease. Limitation of the destructive process is usually controlled by the formation of fibrous tissue, into which the deposit of lime salts is strikingly absent. Some observers[1] contend that ankylosis of tuberculous joints is always fibrous, bony union never taking place, except after a resection of the joint, or in children after a mixed infection has occurred. Tuberculous spondylitis affecting the bodies of the vertebræ has been no exception to this rule and, until a comparatively recent time, the author has been inclined to doubt the diagnosis of spinal tuberculosis in those cases in which hypertrophic bone changes were shown to exist during the acute stage of the disease.

LITERATURE.

The literature dealing with tuberculous spondylitis has been searched in vain for any accurate description of this condition. John Fraser[2] states "that it is an interesting fact, and one which has never been explained, that in tuberculosis of the vertebræ the periosteum rarely forms any degree of new bone." However, it has long been a common observation that bony ankylosis of the vertebræ does often occur in the later stages of those cases in which sinuses have existed for some time and in which secondary infection has been allowed to creep in.

Willis C. Campbell[3] reports four cases of localized spondylitis in which the roentgenograms show crescent-shaped lamellæ of bone extending from the body of one vertebra toward its adjacent fellow and which may completely encapsulate the disk, producing a solid external fixation of the two vertebræ. His conclusion is, that the etiologic factor is probably the same as in monarticular osteoarthritis, and while he does not rule out the possibility of a tuberculous infection in all his cases, he evidently does not consider it likely that he was dealing with tuberculous spondylitis in which hypertrophic bone changes had taken place.

French contributors have described a condition, under the caption of *Spondylitis rhizomélique*, which occurs in phthisical subjects in whom the whole spine slowly becomes stiff and fixed throughout its entire length. A. H. Tubby[4] considers that this form may be a *superficial caries* of the bodies of the vertebræ which is accompanied by inflammatory and osteophytic changes in the intervertebral articulations. He is inclined to believe that this type is a discrete tuberculous infection of the entire spinal column.

CLINICAL CONSIDERATION.

A study of one hundred consecutive cases of tuberculous spondylitis occurring on the orthopædic service of the Cincinnati General Hospital has disclosed ten subjects in whom hypertrophic bone changes were present during the active stage of the disease. The condition in five patients was confined to monarticular lesions, the other five showing two or more attempts at bony bridging in contiguous areas of the spine. In six of the ten subjects a cold abscess was present, but in only one had drainage of the abscess been performed previous to the roentgenologic examination and therefore the possibility of extraneous infection could be eliminated. In the six patients with cold abscesses, aspiration or drainage operations were performed and typical tuberculous pus was evacuated. Hypertrophic bone changes have invariably been confined to individuals over twenty years of age and have accompanied lesions located in the lower dorsal, dorsolumbar, and lumbar vertebræ. This would indicate an effort to limit motion, as a part of the healing process, in these regions of the spine which sustain the strain of greatest weight-bearing and motion. Only those subjects in which the least possible doubt existed concerning the tuberculous nature of the disease have been included in this study, and while it has been difficult in many instances to secure confirmatory laboratory findings in all cases, there were two with abscess in which the tubercle bacillus was found in the pus and positive inoculation of the guinea-pig was performed. In five of the subjects there was positive evidence of pulmonary phthisis and in *none* was there a positive Wassermann reported. Seven patients have improved with conservative orthopædic treatment, which has included immobilization of the spine with some external fixation; three have died following complications.

GROSS PATHOLOGY.

From one subject who died and came to autopsy, the spine was removed and careful dissection made (Case No. 6). There was a large sinus on the right side leading into the body of the second lumbar vertebra; the entire lumbar spine was rigid, no collapse having taken place. Hypertrophic bone changes were found extending from the second to the third lumbar vertebra, both anteriorly and laterally. Further dissection revealed that the twelfth dorsal was firmly fixed to the first lumbar and that the second, third, and fourth lumbar were firmly ankylosed by periosteal over-production of new bone, all of which did not appear distinct in the roentgenogram. The lamellæ of new bone took the same course as the ligamentous fibers of the anterior and lateral spinal ligaments, the fibers being firmly attached to the hypertrophic bone formation, suggesting the possibility that the new bone deposit had occurred within the ligaments, to some extent at least. The body of the second lumbar vertebra showed an extensive carious degeneration. A firm ankylosis was produced embracing that section of the spine extending from two vertebræ above the tuberculous lesion to two below. The entire specimen very strikingly portrayed a natural attempt toward spinal fixation such as we attempt to produce surgically, either by the spinal fusion operation of Hibbs or by the Albee bone graft.

CONCLUSIONS.

Tuberculous spondylitis shows a natural attempt toward spinal fixation by hypertrophic bone changes in at least ten per cent. of cases.

This natural attempt toward spinal fixation by bony bridging is most likely to occur in that portion of the spine in which there is the greatest freedom of movement, *i. e.*, the lumbar region.

Bony ankylosis of the spine may occur in tuberculous spondylitis without the presence of a mixed infection.

It is possible that many cases of spondylitis, diagnosed monarticular osteoarthritis, are of tuberculous origin.

This condition has not been found, except in those who have attained adult age.

Since spinal fixation has long been considered the most rational treatment for tuberculous spondylitis, and since bony fixation occurs naturally in a certain percentage of cases, it would seem justifiable

to recommend internal fixation by bone graft or spinal fusion as a most rational aid toward recovery, especially in the adult.

CASE REPORTS.

CASE 1.—A-5716. Age 29, saleslady. Admitted, August 23, 1916; discharged, December 18, 1917.

Complaint—Swelling in the back and thigh.

Family History—Negative, except one sister died at the age of three months of pneumonia. No history of tuberculosis in family.

Past History—Diphtheria at the age of six, typhoid at eighteen, otherwise always been well.

Present Illness—Began five years ago with severe cramps in the lower region of the abdomen. Was operated on for a strangulation of the bowel at this time. Eight months afterwards a large abscess formed in left groin and was drained. Six months later another abscess formed in the lumbar region which was drained. Wassermann negative.

X-ray—August, 1916, shows a bony bridging connecting the 3rd and 4th lumbar vertebræ on the left side. There is also seen the formation of bone connecting right transverse process of the 5th lumbar vertebra with the sacrum.

CASE 2.—B-7565. Age 24, Italian, laborer. Admitted, November 22, 1917; died, May 29, 1919.

Complaint—Pain in the region of the hip joint.

CASE NO. 2.—B-7565. X-ray shows firm bony bridging between 2nd and 3rd lumbar vertebræ on the right side.

Family History—Negative.

Past History—Has always been well. Never had any illness to cause him to stop work until one year ago when he was injured by being crushed by a steel crane. Was in the hospital for two weeks. Habits are good. Never had any venereal diseases.

Present Illness—Began about five months ago with occasional pain in the front of the thigh, in the lower portion of the back. Intervals of pain gradually became more frequent and more severe. Stiffness of the muscles around the right hip noticed. He gradually lost his ability to bend forward and to the right. Abscess in right lumbar region was aspirated and later drained by operation. Pus was inoculated into a guinea-pig and tuberculosis found on autopsy. Wassermann negative.

X-ray—October, 1917. Bone destruction in the 2nd and 3rd lumbar vertebræ with bridging on right side.

Case 3.—Age 44, married, laundress, colored. Admitted, March 16, 1919; discharged to Branch Hospital for Consumptives, September 4, 1919.

Complaint—Pain in the lower part of the back.

Family History—Mother living and in good health. Father died of bronchitis. Three brothers and two sisters living and well. One sister died of heart trouble.

Past History—Had operation for fibroids several months ago. Usual diseases of childhood. Has suffered with rheumatism. One year ago first noticed a bulging in the spine and has had severe pain in the abdomen for several months. The limbs gradually lost their power; has not been able to walk for about one month. Legs stiff and numb. Has been going about the house on her hands and knees. Husband has been massaging her back over the prominent vertebra. No history of cough but she has night sweats.

Present Illness—Legs are spastic, but can still move them voluntarily. Wassermann negative.

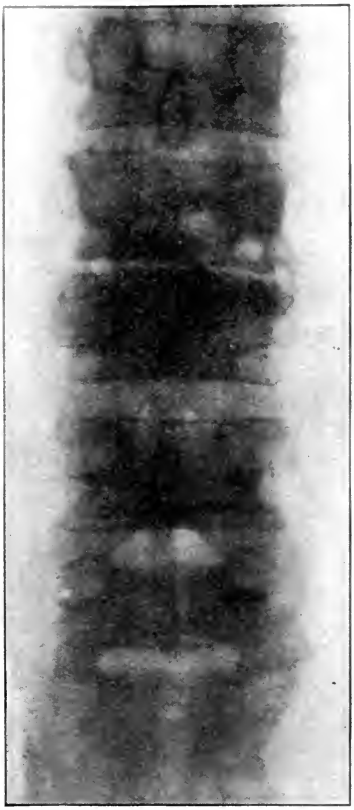
X-ray—March 18, 1919, taken of the dorso-lumbar spine shows a deposit of bone almost amounting to complete bridging on both sides of the inter-vertebral joint of the 11th and 12th dorsal vertebræ. There is also fusion in the region of the 7th and 9th dorsal vertebræ, with some bony destruction and absorption of the intervertebral disk.

Case 4.—D-3601. Age 60, married, housewife. Admitted, June 1, 1919; died, September 11, 1919.

Complaint—Pain in the back and legs; numbness extending from the abdomen to the feet.

Family History—Mother and father dead. Mother died of asthma, one brother died at the age of fifty-seven, of asthma.

Past History—Usual diseases of childhood, rheumatism since age of fifty-two. Has had two children, one died at age of four years of brain fever, second child died when born. Denies any venereal infection. Habits good.



CASE No. 6—D-8013. X-ray taken of spine after removal at autopsy, showing destruction of the 2nd lumbar vertebra and bony bridging between 2nd and 3rd lumbar on the right side.

Present Illness—Began twenty-six weeks ago with pain in the back and legs and has gradually increased and is now unable to walk or stand. Wassermann negative.

Was operated upon by surgical service July 28th. Incision made at the level of the 10th and 11th dorsal vertebræ. Some yellowish purulent fluid was evacuated and somewhat cheesy pus appeared in the wound. Dura was exposed, the cord revealed an abnormal appearance. Cigarette drain applied and the wound was closed. Slight improvement followed laminectomy.

X-ray—Examination, June 9, 1919, showed bridging between 2nd and 3rd lumbar vertebræ. Lateral view shows no evidence of bone destruction. August 22nd, x-ray shows marked destruction of the body of the 3rd lumbar vertebra.

Case No. 6.—D-8013. X-ray shows destruction of the body of the 2nd lumbar vertebra and inter-vertebral disk between the 2nd and 3rd lumbar. Bony bridging between the 2nd and 3rd lumbar on the anterior surface.

Case 5.—D-3861. Age 25, single, gardener. Admitted, May 19, 1919; transferred to War Risk Service, May 29, 1919.

Complaint—Abscess in the back following a sprain two years previous, caused by heavy lifting.

Family History—Negative.

Past History—Negative. Denies venereal diseases.

Present Illness—About May 5th, 1919, began to have pain and swelling in the left lumbar region and unable to bend forward. Abscess was aspirated and pus obtained which was sterile. Guinea-pig inoculation negative. Wassermann negative.

X-ray—August 25, 1919, shows bony lipping between the bodies of the 4th and 5th lumbar vertebræ, also bony outgrowth at the right side of the body of the 4th lumbar vertebra. Lipping also between 12th dorsal and 1st lumbar.

Case No. 6.—D-8013. X-ray taken of spine after removal at autopsy, showing destruction of the 2nd lumbar vertebra and bony bridging between 1st and 2nd lumbar vertebræ.

Case 6.—D-8013. Age 23, laborer, colored. Admitted, December 8, 1919; died, September 30, 1920.

Complaint—Mass in the right side of the back.

Family History—Reveals no evidence of tuberculosis.

Past History—Patient had the usual diseases of childhood and has always been well until the Fall of 1918, at which time he states, he was in the hospital with a fever. Has always been regular and moderate in all his habits.

Present Illness—Began March, 1919, at which time he fell from a step-ladder, landing on his right side. Following morning began to suffer with severe pain in the right side, increased on any movement of the spine. Swelling first appeared in June, 1919. December 12, 1919, 170 c.c. of greenish-yellow pus was aspirated and sent to the

laboratory. On February 24, 1920, abscess was drained. December 13, 1919, acid fast bacillus found in pus; culture negative. Wassermann negative.

X-ray—December 12, 1919, showed marked bony destruction of the 2nd and 3rd lumbar vertebræ and thinning of intervertebral disk with bony bridging extending between 2nd and 3rd lumbar vertebræ. Findings suggested tuberculosis involving chiefly the second lumbar vertebra.

CASE 7.—E-1908. Age 23, single, clerk. Admitted, March 1, 1920; discharged, March 27, 1920, to return later.

Complaint—Pain in the back, especially on bending forward.

Present Illness—Began about January 28, 1919, while riding on a truck in Germany. Patient lay in a hay loft in a barn over three days without being able to move. Back was then strapped and he was taken to a hospital where he remained for six months.

Examination—No deformity present. Limitation of spinal movements in all directions. Wassermann negative.

X-ray—Made March 5th, 1920, shows new bone formation projecting from the edges of the body of the 5th lumbar vertebra, also slight lipping of the body of the 3rd lumbar vertebra. Between the bodies of the 1st and 2nd lumbar vertebræ on the left side there is evidence of bridging; also a rarefaction in the 5th lumbar vertebra suggesting a tuberculous condition. Patient was treated with cast and referred to War Risk Ward.

CASE 8.—E-3215. Age 46, married, laborer. Admitted, April 17, 1920; dismissed, June 6, 1920.

Complaint—Chronic lame back.

Family History—Mother and father living. Two brothers living and well.

Past History—Had pneumonia twenty-five years ago at Bellevue Hospital. Influenza, 1918 and 1919. Ordinary diseases of childhood. History of chancre when seventeen years of age. Has had gonorrhea. Has lost about forty pounds since 1918. Regained some weight.

Present Illness—Started in December, 1919. Attempted to swing on a car and felt something give way in his back. Was examined at the out-patient department and referred to Branch Hospital for Tuberculosis where he stayed until February, 1920. Is unable to stoop over or bend to either side without great pain. Is better when resting in bed. Wassermann negative.

Diagnosis—Spinal tuberculosis. Pulmonary tuberculosis.

X-ray—April 21, 1920, shows marked bony destruction of body of 2nd lumbar and lesser bone destruction of body of 1st lumbar vertebræ. There is a bridging between bodies of 1st and 2nd lumbar vertebræ, on the right side.

Roentgenologist's opinion, tuberculosis of spine.

Patient returned for body jackets. Condition improved.

CASE 9.—E-5397. Age 45, single. Admitted, July 20, 1920; discharged to Branch Hospital for Consumptives, August 10, 1920.

Patient sent into the General Hospital from the Tuberculosis Sanitarium where he has been for eight years suffering from pulmonary tuberculosis.

X-ray—Plates of the dorso-lumbar spine show a gross bone destruction of the bodies of the 10th, 11th, and 12th dorsal and 1st and 2nd lumbar vertebræ. There is bony bridging between the bodies of the 1st and 2nd lumbar vertebræ, on the right side. There is an area of increased density extending about the dorsal vertebræ laterally on either side about one inch, giving an appearance of an abscess formation.

CASE 10.—E-8076. Age 42, male, clothing cutter. Admitted, November, 1920; has not been discharged.

Complaint—Pain in the lower part of the back.

Family History—Mother living and well. Father died at age of sixty-eight, cause unknown. One sister living and well.

Past History—Has had cough for the past two years, which has decreased somewhat at the present time. Does not have night sweats. Has lost eighteen pounds in weight. Denies venereal infection. Had influenza two years ago.

Present Illness—Pain began as a dull, continuous ache in the lower part of the back in October, 1919. Began very gradually but continuously increased in severity. Coughing or sneezing increases the pain in the back. Patient has observed difficulty in putting on his shoes and socks, or when bending over to pick up anything from the floor. At night when asleep he is often awakened suddenly by severe pain in the back.

Examination—Patient moves very carefully, sitting down or getting up very cautiously. There is limitation in all movements of the lumbar spine. Muscles are tense. The 4th lumbar vertebra shows a prominence, but there is no tenderness on pressure. Wassermann negative.

X-ray—Taken January 25, 1921, shows destruction of the 4th and 5th lumbar vertebræ with bridging connecting the left sides of the bodies of the 4th and 5th lumbar vertebræ.

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EARLY SYMPTOMS OF SPINAL CANCER.

BY EDGAR D. OPPENHEIMER, M.D., NEW YORK.

CARCINOMA of the spine, that is, of the bodies of the vertebræ, is not a very unusual condition. Indeed the spongy bones, particularly the bodies of the vertebræ, are probably the most favored sites for the location of metastases. With increased facilities for autopsies and more thorough examination of the skeleton in patients having died of carcinoma, the pathologist has come to recognize this connection as a matter of course.

The clinician, however, not so favored, still fails to appreciate this coincidence and frequently fails to recognize metastatic carcinoma of the spine and other bones until he has had to undergo the mortification of an incorrect diagnosis and prognosis. Such failures are not, however, always due to superficial examination. It is true, of course, that those who, like orthopædic surgeons, are insistently concerned with anomalies, infections, tuberculosis, and syphilis of the spine, are apt to bear these in mind more or less to the exclusion of much more unusual pathological processes. The mistaken diagnosis cannot, however, be wholly attributed to this cause. For though in well advanced cases with evident primary foci the diagnosis is obvious, the correct interpretation of the symptoms in the early stages is often fraught with difficulty, even with suspicions aroused and in spite of the most painstaking examination.

The difficulty is due to the fact that all pathological conditions—and this applies particularly to carcinoma—cause no definite objective symptoms as long as they remain confined within the substance of the bones. In tuberculosis and other infections it is true the focus soon leads to an inflammatory reaction on or near the surface, and this is usually manifested by muscular spasm, and as a consequence spinal rigidity. But spinal rigidity occasionally accompanies malignant disease of the spine, and there are cases in which pain and restricted motion of the spine are the only symptoms over a period of months. When a primary focus cannot be discovered, and the radiograph is negative or doubtful (not a very usual happening in such cases), the differential diagnosis will sometimes try the skill of the most expert.

Even at a later stage, when there are definite signs of bone destruction, the character of the change in the conformation of the spine is not always decisive, as is generally supposed. A well-rounded kyphosis that extends over a number of vertebræ, accompanied by rather

slight and ill-defined pain, may appear in Pott's disease; on the other hand, an acute angular kyphosis is occasionally the earliest manifestation of carcinoma. We have seen cases in which it was, in the absence of a primary focus and other symptoms, very difficult, or quite impossible, to differentiate these conditions even with the aid of an expert radiographer. This, of course, is a very unusual coincidence.

Symptoms of root invasion, in the absence of the bony changes of tuberculosis or other infections, are for the most part characteristic of carcinoma. They are not, however, absolutely pathognomonic, for these symptoms sometimes present themselves as early manifestations of tumors or other diseases of the spinal meninges. The appearance of the segmental symptoms of spinal compression soon leads to the differentiation of meningeal tumor, etc., from carcinomatosis; in one case under observation the segmental symptoms of a tumor of the meninges were late in appearing and the diagnosis remained in doubt for a period of two months.

It is needless to enter into a detailed discussion of all the difficulties that may be encountered in the differentiation of spinal cancer. What has been said suffices to bring out the fact that even in the late stages, when the symptoms are usually quite definite and generally appreciated, we may occasionally be unable to make a proper diagnosis, and this in spite of the most painstaking and expert examination.

This being true, it is not surprising that cancer of the spine is often entirely unsuspected during the early stages. At this period there is little danger of mistaking the condition for mycotic or tuberculous spondylitis or other organic lesions, but there is, not a possibility, but a great probability, that the condition be misinterpreted as functional. Vague back pains, ill-defined pain on pressure over the spine or the sacro-iliac, and negative x-ray report, too readily tempt one to consider the condition functional. No doubt many of us remember such cases.

With this circumstance in mind, I decided to examine critically the rather numerous cases of carcinomatosis that have come under my notice in the Montefiore Home and elsewhere, in an attempt to discover a train of objective symptoms so characteristic that one could make the diagnosis of cancer of the spine earlier and more definitely.

Pathological processes within the vertebræ apparently cause no symptoms as long as they remain within the interior of the bone. Symptoms appear,—(a) when the process begins to emerge from within and invade the extramedullary tissues, or, (b) when the bodies of the

vertebræ have been undermined, and give way, and the spine undergoes changes in contour.

The methods of differentiating cancer from other lesions of the spine must therefore be founded upon,—(a) a characteristic manner of invading the surrounding tissues, *i. e.,* the spinal cord or roots and, (b) characteristic changes in the contour of the spine.

The symptoms of actual invasion of the spine or the spinal roots are of course striking; the continuous indescribable agony that attends the carcinomatosis of the spine is fortunately characteristic of no other pathological process. Before extensive root irritation has occurred the symptoms and objective findings are not so definite and, in the absence of a demonstrable primary focus, are often difficult to interpret. According to the leading authorities, marked continuous neuralgic pains, especially bilateral or segmental in character, not influenced by the usual therapeutic remedies, should lead one to suspect cancer. In connection with other signs and symptoms, however, they are often of service in making the diagnosis; thus, continuous bilateral sciatica often leads to the search for and the discovery of a heretofore unsuspected primary cancer. It should lead to a search for cancer in situations where primary carcinoma is sometimes overlooked, unsuspected or difficult to demonstrate; *viz.,* the lungs, thyroid, and prostate. When, however, the cancer cannot be demonstrated elsewhere, then the root symptoms, as the following case history illustrates, are difficult to interpret.

A. B. Aged 52. Previous history: For the past six months has been complaining of pain in the hypogastrium, which has gradually increased in severity until now it is difficult to relieve, and then only temporarily by morphine. He was in the care of a gastroenterologist for some months and was treated for gastric or duodenal ulcer. As he was not relieved he sought advice from a number of others and the removal of the appendix was advocated. Examination shows a fairly well nourished individual; complains of pain in the pit of the stomach, which is continuous, and not relieved by heat or change of position, and only partially by opiates. Abdomen flaccid with no signs of abnormality of the contained organs. Suggestion prompts him to describe the pain as radiating from the spine forward. Medical, physical, Wassermann, etc., negative. Spine rigid but without local tenderness; x-ray shows no definite abnormality in the spine, other bones not taken. The rigidity of the spine and the pain radiating to the hypogastrium suggested a spondylitis, and cancer was not suspected. For this reason the spine was immobilized in a plaster of Paris jacket. Instead of the expected relief, the pain increased to such an extent that after a few

days the jacket was removed. Subsequently he suffered spontaneous fracture of the ribs and developed the symptom complex of general carcinomatosis.

This case, which resembles a number of others which have come under observation, is instructive in a number of ways. It illustrates not only the difficulties in the way of diagnosis, but it suggests some differentiating factors; thus for us, continuous pain more or less segmental in character, indefinite or negative x-ray findings with spinal rigidity, particularly when the condition is exaggerated by immobilization, always leads to a search for a primary carcinoma and, even when this is absent, strongly suggests malignant disease. We have not been able to discover why immobilization increases the pain in these cases (it is likely that it prevents the patient from assuming an attitude that somewhat alleviates the suffering), but in a number of cases this aggravation of the symptoms has occurred and we now consider this coincidence as definitely suggestive of carcinomatosis.

We have concluded, from an examination of the cases, that the early signs of root involvement from carcinoma have the following clinical manifestations. The symptoms are those of sensory root irritation as distinguished from a peripheral nerve lesion. What is usually designated as a bilateral sciatica is not a sciatica, but the pain and its distribution will, on careful examination, be found to correspond to one or more roots of the sacral plexus. When the spine higher up is involved, the symptoms are clearly segmental in character; usually other sensations are intact and the motor sphere is only involved late in the disease. The pain is always greatly exaggerated by immobilization; is more or less continuous; it prevents but does not interrupt sleep as does the pain in spondylitis. These symptoms appear with or without spinal rigidity and are not infrequently present when the radiograph of the spine is negative. They are in themselves not characteristic but should always arouse suspicion and encourage the search for primary carcinoma, and, in conjunction with other suspicious signs, often secure the diagnosis.

In many of the individuals seen early, that is, before the disease has reached the extension of the vertebræ, the subjective symptoms are vague. The patient complains of pain in the back, over the sacrum or the sacroiliac joint, and frequently is unable definitely to localize it. In such cases we have tried to discover the earliest changes in the spine. That is, we have searched for the objective changes that precede the characteristic x-ray findings and the actual gross deformation of the spine of extensive cancer invasion.

Until recently our histories show that we had not demonstrated these

changes. This was due to the fact that we made no careful search for them or, as it is true of the root symptoms in many of our earlier cases, we did not properly interpret or lay sufficient stress upon them. Since we have studied the subject more intensively we have found that it is often possible to foretell the ultimate vertebra breakdown long before it actually occurs and not so rarely before the radiograph gives positive results.

Of these changes, most typical is slight dislocation forward, so that there appears a more or less definite recession of particularly one or a few spinous processes as they are successively palpated from above downward. In some of the more marked cases the palpating finger suddenly meets with a sharp depression as it reaches the subluxated vertebra.

In another group of cases we have been able to discover the presence of slight later displacements which only months afterward became pronounced. This change is due to carcinomatous invasion of the lateral processes and the ligaments of the lateral joints of the spine. In two cases we have found slight lateral displacement the only symptom except vague back pains. In the absence of demonstrable primary carcinoma, the diagnosis in these cases remained in doubt for some months, and was not definitely confirmed until symptoms of general carcinomatosis appeared. In two others, marked lateral dislocation and other changes soon followed the discovery of the slight displacement.

In another group of cases we have been able to demonstrate the compression of the bodies of individual vertebræ as it occurs very early in the disease and before it is apparent in the radiograph, by what we think is a change in the relation between the adjacent spinous processes of the affected vertebræ. Rarely, the only change is a shortening of the distance between the adjacent spinous processes; more often the change in the height of the vertebræ is complicated by a variable amount of torsion.

These changes in the contour are, of course, not absolute criteria in the absence of other symptoms. They are, however, very suggestive in connection with other symptoms not in themselves definite. In practically all the cases that we have been able to follow up, the diagnosis was substantiated. And though we are far from assuming that these slight objective differences in the contour of the spine are pathognomonic of cancer, we feel that slight lateral displacements, discrepancies in the relation between adjoining spinous processes, with or without lateral deviation or torsion, are very significant symptoms.

At least they should lead one to suspect cancer, and therefore strongly stimulate the most thorough search for other evidence of carcinomatosis.

With the facilities for thorough search for primary cancer and the expert radiography at our command in all general hospitals, why, it may be asked, is it necessary to seek new clinical data, or magnify the significance of the changes we have here described? But it has been our experience that if we except the more common carcinomata the primary focus is not always easy to demonstrate. Indeed, in some of our cases the primary carcinoma in the prostate, thyroid or lungs had not been demonstrated in patients with general carcinomatosis until they came to autopsy. Nor does the radiograph always clear up the diagnosis in the early stages. We have seen cases in which the radiograph was apparently negative three or four weeks before the characteristic deformation and symptoms of advanced carcinomatosis supervened. Of course the advanced cases show characteristic changes with which all are familiar. The early pictures are, however, often negative, or cannot be definitely interpreted without additional clinical data. We have carefully re-examined a great number of the plates taken at the Montefiore Hospital, where there is a large cancer service, without being able to find definite and characteristic findings for the earliest stages. Slight changes in the outline of bodies. sometimes shown only in the oblique pictures, are the usual first signs. The only additional assistance we have derived from this source was obtained by radiographs of the other bones when the plates of the spine were negative, because we can, for technical reasons, demonstrate more easily the lesion in the femur, humerus or skull. In this we have been able to confirm the observations of others that at times cancer of the femora or other bones could be demonstrated when the symptoms apparently originated in the spine, but the plates of this region were negative. The characteristic small, well-defined shadows due to multilocular growths are striking, but occur late, and the early x-ray diagnosis must usually rest on a careful study of all ill-defined shadows so often described as "picture unsatisfactory." These lesions are rapid in growth and the comparison of weekly radiographs will show an increase of a suspected lesion and allow us to state that real atrophy exists, not comparative atrophy.

On the whole, then, according to my investigation, the early diagnosis of cancer must be in many cases tentative. It can be verified by the search and demonstration of primary foci elsewhere. In conjunction with other symptoms, in themselves not decisive, the peculiar character

of the root or segmental symptoms, or the early changes in the conformation of the spine here described, will often greatly aid in securing the diagnosis.

I herewith append an abstract and an analysis of the history of thirty-two cases of cancer of the spine under observation at the Montefiore Hospital on whom satisfactory data were obtainable. I am indebted to Dr. I. Levine who has charge of the Cancer Service for permitting me to use his cases.

The site of the primary lesion was found to be in the breast eighteen times, lung four, prostate five, thyroid three, kidney one, pancreas one, in a total of thirty-two carcinomata. The metastatic symptoms appeared before the primary focus could be determined in twelve cases. Three cases in addition, presenting spinal symptoms, had breast operations eight years previous without recurrence, and the symptoms of the metastases took that length of time to become evident. The primary lesion was not found at all clinically in six cases and proved at autopsy to be in the breast one, thyroid two, lung one, prostate two. Pathological fractures were present before the diagnosis of carcinoma was established in the spine four times, femur three, humerus two, elsewhere two. The first symptoms in seven cases, in which there had been no local pains, were fractures following slight trauma. Local spinal symptoms were present in twenty cases early in the history; ten showed pain on local pressure, and fourteen deformity. In no case was there tumor present on the spine, and sacral tumors in three cases appeared only late in the disease. Spinal pains were complained of in nineteen cases and were an early symptom in nine cases. In fifteen cases the lower extremities were the seat of pain and in thirteen cases this was an early symptom. Symptoms of metastases, other than spinal, were present in sixteen cases and early in thirteen cases. Sensation of cold was complained of in thirteen cases, and herpes zoster was found in two cases. We found positive spinal x-rays in fifteen cases and in eight they were negative. Of the eight negative cases, three showed lesions in other bones. The cases with early cord and root symptoms, as a rule, gave negative pictures at the time of onset and some even at the end. Our cases presenting metastatic bone and cord symptoms gave an average duration of fourteen months. The duration of nerve symptoms in seventeen cases averaged ten months, and fifteen cases had no symptoms referable to the central nervous system.

Case 1.—01207. E. H., female, aged 60 years. Admitted April 9, 1917; died April 13, 1917. October, 1915, had pain in right foot

and knee grew gradually worse and was bedridden all winter. April, 1916, was seven weeks at C. N. Hospital for constant pain in lower portion of spine and weakness of both lower limbs. X-ray diagnosis—Pott's disease. Six weeks in plaster corset; after removal of corset developed hematuria. October, 1916, was sent to Mount Sinai Hospital where hematuria was controlled and examination showed round diffuse kyphos in upper dorsal region with immobility but no acute spasm. Vertebræ not sensitive. Paralysis of lower extremities. X-ray showed almost complete destruction of second and third lumbar and changes in the 1st, 4th, and 5th lumbar vertebræ. Diagnosis, T. B. C. or malignant. On admission to Home —for last six months increased frequency of urination—for one month complete transverse myelitis. X-ray—large neoplasm entire lumbar spine, metastases in dorsal spine, femora, ribs, signs of arthritis deformans. Autopsy—Carcinoma breast, metastases in spine 7 to 11 D, 2 to 5 L, skull, bones, liver, glands.

CASE 2.—PP 14. H. McM., age 79 years. Admitted, May 30, 1917; died September 11, 1917. For several months indefinite pains in back, sticking in character and fairly constant, not influenced by treatment or medication. X-rays,—kidneys negative, spine moderate arthritic changes. Spinal brace for arthritis made pains worse. Unable to wear brace. On admission severe pains in back and shoulders, pains in legs, and weakness. X-ray in July, 1917, showed aneurysm in arch of the aorta, heart enlarged, lungs negative, no bone changes. The paralysis of legs gradually increased, followed by a transient Brown-Séquard crossed paralysis, and on September 5th complete paraplegia below the waist and a gradual kyphos at dorso-lumbar region. Prostate enlarged with hard nodules. Diagnosis: carcinoma of prostate, metastases of spine and cord.

CASE 3.—02150. H. H., male, age 48 years. Admitted, March 12, 1919; died April 12, 1919. September 10, 1918, on jumping from a street car had severe pain in heel and toes of right foot. A week later was told he had a fracture. Massage and baking ordered but discontinued on account of excessive pain. In plaster of Paris for five weeks. Removal of plaster aggravated the pain. Then pills and five intravenous because blood was positive. January 20, 1919, amputation of leg was made; since that time noticed swelling at groin and at finger. On admission, has a sacro-iliac tumor, apparently osseous. March 23d, cerebral thrombosis, facial palsy followed by partial recovery. Autopsy—primary carcinoma lungs, metastases of bones, sacrum, skull, hands, liver, adrenal, lymph glands, dura, scoliosis.

CASE 4.—0943. Male, age 62. Admitted, April 11, 1916; died, September 7, 1916. For seven months had chills, weakness, dyspnoea, loss of weight. On admission:—expectoration, pain in chest, lung signs. July 21, 1916, painful nodule on clavicle, later pathological fracture. X-ray:—April 24, 1916—cavities and fluid in lungs. July

25, 1916,—pathological fracture of clavicle. Autopsy:—carcinoma of lung with extension of mediastinum, involving 4th and 5th dorsal vertebræ. Collapse of bodies and extension into outer layer of dura.

CASE 5.—0841. Male, age 52 years. Admitted, December 16, 1915; died May 6, 1916. Two years ago had cutting pain in left lower extremity from pelvis radiating down the inner side to ankle, and six months later similar pains in right limb. Plaster jacket for six months did not relieve the pain. Pain not constant and not definitely located; most of the pain in legs down to ankles. No pain in feet and could not walk or sit. Turning in bed gave sharp pain in back of pelvis; only when on either side did he find comfort. On admission—complains of pain in pelvis and both lower extremities; consequent inability to walk any distance. Thyroid negative, neurological negative; spine not tender; no deformity or rigidity. Pains considered functional. January 25, 1916—pains vague and irregular, at times severe and frequently absent. On rotation intense sacral pains; prostate somewhat hard and enlarged. X-ray—slight defect in the outline of the body of the 4th lumbar vertebra not clear. April 16, 1916—very severe pain in both hips; motion left lower limb limited and very painful; knee jerks absent. X-ray, April 20, 1916—defect in 4th lumbar, also 3rd and 5th. Retention of urine and feces developed, also loss of weight. Spine shows no deformity or tumor but has extreme tenderness on pressure over 3d, 4th, and 5th lumbar spine and both sacro-iliac joints. Later followed symptoms of cord involvement. Autopsy:—malignant adenoma thyroid with metastases to lumbar vertebræ. Body of 4th lumbar replaced by fleshy tumor mass penetrating through disc to 3rd and 5th lumbar, tumor encroaching on canal though it does not project through the meninges. Hemorrhage of lumbar nerve root.

CASE 6.—01129. F. G. Male, age 63 years. Admitted, August 24, 1916; died, February 9, 1917. Since January, 1916, had pains in left thigh which were constant, but at times so severe that he could not walk. On admission,—lumbar and sacral spine painful on pressure, more marked on left side. Muscular rigidity but no tumor present. Deep and superficial tenderness of left lower extremity; rectal negative. X-ray, August 31, 1916, general carcinomatosis lumbar spine, sacrum and left femur. Autopsy:—carcinoma of prostate, metastases in bones, femur friable, replaced by tumor.

CASE 7.—0591. B. F. Female, age 56 years. Admitted, July 6, 1915: died, July 25, 1915. One and one-half years ago patient fell and was unable to raise herself. Was put in plaster corset for five months. Since March, 1915, was unable to walk. On admission,—marked tenderness dorso-lumbar spine; entire spine rigid; marked lateral curvature at 2nd lumbar. Entire left lung dull. Autopsy:—primary adeno-carcinoma lung, metastases in pleural, liver, adrenal, ribs, vertebræ, glands, suppurative pericarditis, duodenal ulcer, slight compression of cord equina by metastasis at 2nd lumbar.

Case 8.—01782. B. K. Male, age 40 years. Admitted, June 9, 1918; died, September 9, 1918. July, 1917, cutting, cramplike pain in left inguinal region, radiating to testicle, so severe that patient was unable to walk. Ten months ago pain in left lumbar region, then pain in left axilla, radiating to spine. Pain constant, made worse without cause; no relief from medication or therapeutic treatments. Tenderness over left chest; herpes zoster along course of intercostal nerve. Teeth extracted, February, 1918. Gave streptococcus viridans in pure culture as did the tonsil. Wassermann negative, spinal fluid negative. X-rays, February 25, 1918,—sinuses, cloudiness of both anterior ethmoids. X-ray of spine unsatisfactory. Considered a pernicious neurotic. For past two weeks pains in right hip, increased by motion. Small swellings over ribs anteriorly and behind ears. On admission,—pains in back, shoulders, hip, stiffness of neck; masses over chest and hip painful on pressure. Loss of weight, fifty pounds in year. Small, hard mass in front of neck, not painful. On examination, patient very sensitive; flexion left thigh causes severe pain, as does any motion. No tenderness of vertebræ or femur. Feeling of cold in right lower extremity. June 28, 1918, prostate negative. Very hard tumor size of nut adherent to fascia and laryngeal cartilage; not painful. X-ray, June 18, 1918,—small diffuse spots throughout bodies of vertebræ and 12th rib. Multiple fractures of ribs. Irregular bone destruction along S. I. joints, pelvis, and left femur. Infiltration of lungs with carcinoma of thyroid. Metastases of bones and lungs.

Case 9.—0734. F. E. Female, age 56 years. Admitted, November 10, 1914; died, January 1, 1916. Onset, 1911, with pains in thighs. Breast amputated, September, 1913. After one year, recurrent, followed by marked weakness; no muscle atrophy. Could not raise heel off bed. Neurological examination negative. December 24, 1915, fell off a chair, fracturing lower one-third of femur. X-ray showed carcinoma. Autopsy:—ribs, femur, spine showed carcinoma.

Case 10. 0753. Female, age 45. Admitted, October 1, 1915; died, January 22, 1916. One year ago had pain in left arm, and breast was removed. Then developed pains elsewhere; these grew worse and the patient weaker. On admission,—atrophy, small muscles right hand; painful spots on spine; swelling on lumbar region; bed sore; increased reflexes; later, signs of cord compression. X-ray, October 14, 1915,—metastases show in all bones, best in hips, shoulders, ribs and skull.

Case 11.—03041. B. B. Female, age 69. Admitted, July 30, 1918; died, November 19, 1920. Five years ago bloody expectoration, ill four weeks. Well for two years, then pain in right foot and leg. Pain beginning in hips and radiating downwards, then pain in both legs, edema of legs. Stiffening and weakness of right hand. Diagnosis:—Mitral regurgitation, arteriosclerosis, chronic arthritis, facial palsy,

October 14, 1920, recurrent carcinoma right breast, ulcerations on cuirasse. X-ray:—Marked hypertrophic anthritis of spine, metastases not evident.

CASE 12.—0761. R. R. Female, age 43. Admitted, January 1, 1916; died, February 3, 1916. May, 1915, noticed tumor in breast. Operated in August. Then followed pains in thighs, later in spine, also of piercing character. Pain on pressure along spinal processes. Kyphos evident and thickened trochanters. X-ray, January 20, 1916,—worm-eaten appearance 11 and 12 D and lumbar vertebræ, also femora. Autopsy:—Dorso-lumbar vertebræ crumble under saw, no definite metastases seen, body of 12th dorsal almost gone, metastases in liver and glands; brain and spinal cord negative.

CASE 13.—02817. H. M. Female, age 43. Admitted, December 9, 1919; died, June 13, 1920. July, 1918, operation right breast. June, 1919, stabbing, right thigh medially, when walking gradually became worse. Last three weeks pain steady in knee and in right hip. Sleeplessness due to pain; five weeks internal strabismus left eye. On admission:—two bony nodules in left parietal region, are not tender. Tenderness of right thigh, cannot lift knee off bed although motions are free. Reflexes normal, no spinal tenderness or deformity. X-ray, December 20, 1919, metastases, skull and right femur, slight erosion at fourth lumbar vertebra. April 11, 1920, irregular bone destruction throughout body of fourth lumbar and both femora where there is periosteal reaction in some places.

CASE 14.—02758. I. K. Female, age 36. Admitted, January 8, 1920; died, May 8, 1920. Four years had mass at suprasternal notch and right supraclavicular fossa which never troubled her. Ten months had mass in right parietal region, never painful. Five months ago stumbled while walking and had severe pains but managed to walk for a month. For increased pain, went to hospital, where cast was applied for fractured femur. On admission:—hard thyroid mass, soft mass at third and fourth rib anteriorly and at parietal, not tender; in plaster cast. January 23, 1920, paralysis of left leg with increased K. J., ankle clonus and Babinsky both sides. February 17, cast removed, decubitus present and signs of complete transverse myelitis. X-ray, January 13, dorso-lumbar spine negative; January 29, extensive bony destruction upper right femur, skull, lower lumbar spine. Carcinoma thyroid, metastases skull, femur, ribs, lumbar spine.

CASE 15.—02873. J. D. Female, age 26. Admitted, January 14, 1920; left, July 28, 1920; died, December, 1920. Five years ago operated, left breast; five months ago pain left hip which interferes with walking. Later, pain in hip less, but pain in lower end of spine; when in bed, pains less. On admission:—complaining bitterly of pain in left thigh with weakness that is progressively worse. X-ray, January

2, diffuse metastatic involvement in pelvis, lumbar spine, skull, lungs; collapse second lumbar vertebra. April 11, large area of bone destruction on upper part of right sacro-iliac and both pubic bones; hips negative. July 8, 1920, no complaints; pain on pressure fourth and fifth lumbar and ribs.

Case 16:—02811. S. R. Male, age 60. Admitted, January 3, 1917; died, June 11, 1920. March, 1915, total excision of bladder for carcinoma. Later, general weakness and lung signs, no spinal symptoms. X-ray, February, 1920, pelvis negative, marked lung shadows, slight metastatic changes of the fifth lumbar vertebra.

Case 17.—02518. Female, age 54. Admitted, May 1, 1919; died, November 24, 1919. May, 1918, noticed lump in breast, marked loss of weight, for three months pain in left eye led to its destruction. On admission:—cancer, right breast, with axillary glands; right upper extremity edematous; August 14, right eye also involved. X-ray, May 13, second lumbar vertebra somewhat collapsed and small area of bone destruction in lumbar spine, sacrum and skull.

Case 18.—02568. R. R. Female, age 50. Admitted, August 22, 1919; died, January 8, 1920. November, 1917, breast removed; April, 1919, for pain in leg went to hospital, while there spontaneous fracture humerus. On admission:—tumor left clavicle; no glandular involvement; fracture humerus; lower dorsal spine shows sharp kyphos. left gluteal bed sore, neurological examination negative. October 29, 1919, patient rather apathetic and complains of cramps. January 2, 1920, no complaints but weaker. X-ray, November 6, 1919, moderate diffuse bony destruction spine, sacrum, pelvis, femora, scapula, humerus and other bones.

Case 19.—0X. A. F. Female, age 40. Admitted, October 12, 1920; died, January 1, 1921. Nine years ago breast operated on, one year ago recurrence, operated; for three weeks weakness of legs, unable to walk; swelling of legs. On admission,—carcinoma on cuirasse; reflexes normal, edema left hip, spine shows marked tenderness of 7 dorsal. X-ray:—spine, pelvis, hips, shoulders negative for metastases.

Case 20.—0X. M. M. Female, age 54. Admitted, December 9, 1920; died, December 10, 1920. Eight years ago lump in breast; operated on April, 1919; well one year, then pain in chest; grew weaker and worse. Five months ago pain more severe; increased weakness and incontinence; one month cannot stand; now transverse myelitis with bed sores and complete paralysis below hips.

Case 21.—02924. B. K. Male, age 56. Admitted, July 29, 1920; died, September 4, 1920. Eighteen months ago influenza; cough persistent and became more constant. Four months drawing pain right

arm and pain right chest anteriorly. August 18, 1920, pain left gluteal region, pain and marked tenderness left sacro-iliac. No symptoms of spine. X-ray, August 4, 1920, beginning bone rarefaction left sacro-iliac and right humerus. Other bones negative. Autopsy:—primary tumor right lung, metastases left lung, ribs, lower spine, direct extension of tumor into superior vena cava.

Case 22.—02251. J. D. Female, age 56. Admitted, May 22, 1919; died, June 21, 1919. Nine years ago amputation of left breast; one year ago pain across back; absent when lying down; on standing, pain down thighs and calves. March 6, 1919, tenderness over mid-lumbar, sacrum, and sacro-iliac joints. Diminished power in wasting right thigh. K. J. absent, no tenderness on stretching sciatic. X-ray showed extensive involvement of lumbar and sacral vertebræ. On admission:—inability to walk, pain in back, radiating down both lower extremities. Incontinence, edema lower extremities; slight scoliosis, abdominal negative; axillary glands palpable; mass above sacrum; vertebræ not tender to pressure; sacrum sensitive, paraplegia dolorosa. X-ray, June 18, 1919, pelvis marked rarefaction and destruction throughout entire pelvis, process most marked in the spine. Marked bilateral hilus shadows in the lungs.

Case 23.—02256. R. B. Female, age 40. Admitted, March 27, 1919; died, June 23, 1919. Ten months ago amputation right breast; three weeks thereafter sudden sharp pain in back of neck, next pain in right shoulder, then in right thigh, so severe patient could not walk. Pain progressed to entire back, abdomen and into left thigh; later, chest and entire body became affected. On admission:—pain all over body, sleeplessness, constipation. On deep palpation back of neck, abdomen, chest painful; axilla free of glands. X-ray, April 18, 1919, marked evidence of small areas of bone destruction throughout bony system, greatest amount in bodies of 10, 11, 12 dorsal.

Case 24.—01293. Y. D. Female, age 42. Admitted, January 7, 1918; discharged July 8, 1918. April 16, 1916, noticed lump in breast which was operated on in June; then pain in right leg. X-ray showed carcinoma. Pains in right hip and right shoulder; active motion lost due to pain. Right leg one and one-half inches short. February 27, 1917, pathological fracture humerus. Tenderness left of lumbar spine. X-ray, right shoulder, absorption of bone; right hip, fracture at neck; much destruction.

Case 25.—01291. R. W. Female, age 40. Admitted, June 14, 1917; discharged, July 7, 1917. Two years ago lump in left axilla noticed. Breast operated on one month later; second operation, January 12, 1917. On admission:—pain all over body, especially in both humeri, left knee and back. Local recurrence at breast; both upper extremities edematous. Abdominal negative; shoulders, hips, and spinous processes all painful on pressure; no deformity, slight limitation flexion

right hip. X-ray,—spine and shoulders negative; hips, left slight destruction below acetabulum,—right, slight arthritic changes.

CASE 26.—01418. M. R. Female, age 48. Admitted, October 22, 1917; died, October 27, 1917. September, 1915, vomiting attacks. Operated for tumor of left kidney; five months ago sitting in chair, was unable to get up, had pain in dorso-lumbar region. On being helped up was unable to straighten back; four weeks later feet began to swell; could not move feet; sleeplessness from pain in back; last ten weeks lost control of bladder, then, also bowels. On admission:—right buttock ulcer, paraplegia, cystitis, metastatic carcinoma dorsal and lumbar spine from left kidney.

CASE 27.—02324. R. S. Female, age 35. Admitted, June 17, 1919; died, July 28, 1919. Nine months ago severe pain in region of stomach, and headache. Constant pain radiating down sides of legs. Examination shows palpable mass attached to liver; spinal column very tender to touch at 8th dorsal and below. June 20, complains bitterly of pains in back; June 26, incontinence, pain all over body. Autopsy:—carcinoma pancreas, liver, and stomach, involving spinal column.

CASE 28.—C2. S. T. Female, age 40. Admitted, June 17, 1920. Four and one-half months ago while stooping found that she could not lift her lower extremity and the next day her right. Difficult walking, weak; later, stabbing pain and burning over entire back; continuous sticking pain in lower part of right chest. May 12, 1920, operation, breast, for inoperable carcinoma. Angulation to left at 3rd and 4th dorsal. On admission:—weakness, arms and legs, reflexes increased. June 25, 1920, local pain in first and second lumbar; no sensory changes. January 16, 1921, no pains now in back; spine somewhat sensitive; gradual kyphos. X-ray, June 21, 1920, rarefaction of bones of spine, rather indefinite.

CASE 29.— C2. S. L. Female, age 42. Admitted, September 22, 1920. Breast operation two years ago; four months ago feeling of cold all over body; three months ago edema of left arm, weakness, left facial palsy, left knee swollen and tender. On admission:—local recurrence, left knee swollen and tender. X-ray, October 4, 1920, left tibia, fibula, femur show a few spots of rarefaction. Moderate irregular rarefaction throughout upper sacrum.

CASE 30.—C3. J. S. Male, age 57. Admitted, April 21, 1920. December 29, 1919, suprapubic operation for bladder stone. Adenoma with carcinomatous changes, also carcinoma prostate. June 19, pain left loin downward to thigh,—urinary disturbance. On admission:—weakness, especially legs, constipated, pain side of thigh, inoperable prostate carcinoma. July 7, 1920, pain left femur, local tenderness. January 17, 1921, spine tender at places, but can walk. X-ray, July

15, 1920, cervical spine negative. August 10, 1920, small areas de struction third cervical. Extensive diffuse rarefaction upper part of femur.

Case 31.—W1. S. G. Male, age 88. Admitted, July 23, 1920. About six months ago weakness of both legs, progressive until unable to stand, followed in one month by inability to urinate. Three months ago prostatectomy for enlarged prostate. On admission:—inability to stand or walk, no bladder or rectal disturbance, no pain, paraesthesia or swelling of extremities. Later, there developed signs of local cord lesion with a zone of hyperæsthesia across chest and paræsthesia of left lower extremity more than right. Distinct depression at height of tenth dorsal vertebra, slight sensitiveness over entire spine. Hard nodule region of prostate now felt. X-ray:—Arthritis of second and third lumbar, otherwise negative.

Case 32.—E2. E. O'G. Female, age 27. Admitted, October 4, 1920. September, 1918, breast amputation. October, 1919, to hospital for back complaints, pain and weakness in lumbar region. Spinal corset gave no relief. Several x-rays were negative; January, 1920, at another hospital, x-rays diagnostic. Radium treatments given. June and July, well again. On admission:—complaint for sixteen months of stiffness in back and pains in back radiating down thighs. Cannot walk, but can stand. X-rays show very marked bone destruction of pelvis and spine. January, 1921, free from pain and has no tenderness on local pressure of spine and pelvis; sensorium intact; distinct depression fifth dorsal vertebra and kyphos upper dorsal. Increased reflexes and spasticity of legs; marked loss of weight, signs of cord compression.

A STUDY OF 208 CASES OF LOWER BACK PAIN.

BY J. R. KUTH, M.D., DULUTH, MINNESOTA.

Complaint of pain in some area of the lower back is a very common one in many conditions. In many cases it is the sole complaint, is chronic, and the etiology is more or less obscure. After thorough physical examination the objective findings are so meagre and indefinite that one is unable to point to a definite area or to a definite lesion and say the symptoms are due to such an injury or to such a disease located in this or that tissue. These patients form a large class commonly seen in private practice and in the practice of the various specialties. The chronicity of these cases and the eagerness with which these patients seek relief indicate the seriousness of the condition and the difficulty of its successful treatment.

The present study concerns itself with 208 cases of low back pain. It does not include cases of obvious or manifest disease or injury of the lower back structure such as tuberculous, typhoid or syphilitic disease of the spine; gross traumatic lesions of the spine or cord or lesions of the cord itself. During the period in which these cases were observed, many women with low back pain were examined and followed for a time. These rightfully belong in this series but are not included because of insufficient data.

There were in the series 136 males and 72 females. The average age of the patients was 37 years (the youngest was 12 and the oldest 70). In 180 cases, previous attacks during the preceding years were admitted by 80, and denied by 100. In 75 cases, possible trauma was given as a cause for the trouble, in 77 there was no knowledge of any injury. In 6, the trouble preceded or followed childbirth.

In 182 individuals, in which the general build and their physical characteristics were noted, 93 were classed as tall or short but strong and muscular, 55 as very fleshy or overweight, 7 as small and thin but strong, 27 were noted as tall, thin, and weakly. Ninety-nine males followed so-called arduous occupations (farmers, factory and ordinary laborers, miners, dock and railroad laborers), 37 were classed as clerks or professional. Of the 72 females, 56 were housewives and the remainder followed the more or less exerting occupations of women.

Pain in the lower half of the back was the chief complaint in all cases. It was localized by the patient either in the middle, or to one or both sides. The most frequent site (see Figs. 1 and 2) was the sacro-iliac area (97 times). Next in frequency were: the lumbar area (55 times), lumbo-sacral area (31 times), gluteal area (19 times), dorso-

AREA	GROUP	R	L	R & L	MID	TOTAL	
Dorsal	I	0	0	0	2	2	2
	II	0	0	0	0	0	
Dorso-lumbar	I	0	0	0	6	6	11
	II	0	0	0	5	5	
Lumbar	I	2	2	20	0	24	55
	II	7	8	16	0	31	
Lumbo-sacral	I	1	0	0	10	11	31
	II	4	0	0	16	20	
Sacro-iliac	I	7	4	3		14	97
	II	37	40	6		83	
Midsacral	I				0	0	1
	II				1	1	
Coccyx	I				4	4	4
	II				0	0	
Gluteal	I	1	0	0		1	
	II	6	10	2		18	

lumbar area (11 times), coccygeal area (4 times), dorsal area (2 times), and in the midsacral area, once. In a little over one-half the cases pain was noted as being in one area only. In the others several areas were complained of at the same time, these as a rule on the same side (Figs. 1 and 2).

Aside from the pain in the lower back, 149 cases complained of other pains radiating into the lower extremities; in 140, the pain followed down the posterior thigh and often into the outer aspect of leg and foot. Five of these, together with 9 others, who complained of no posterior thigh pains, complained of pain in the anterior thigh. These thigh and leg pains were noted as appearing on the right side 53 times, and the left side 60 times, and in both lower extremities 23 times; in 4 cases the side was not noted. These pains were always found on the same side as back pain or on the side where the back pains were severest. In 59 cases there were no complaints of leg pains.

When pains were present in more than one area there was noted a variation in the time of the onset. As examples of this these extracts from the following case histories may serve.

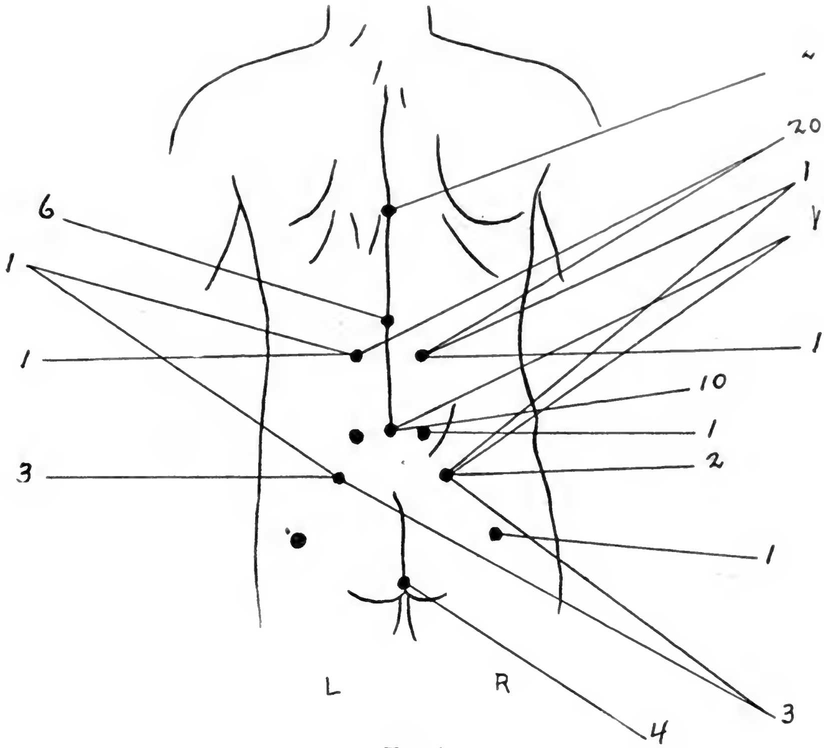

FIG. 1.

CASE 1. S. Male, age 36. A dull lumbar ache for one year, followed gradually by pain localized over the left sacro-iliac area.

CASE 2. G. Male, age 43. (1) Left lumbar pain. (2) After some weeks, a left gluteal pain. (3) Some days later, posterior thigh pain. (Following slight trauma. Marked static abnormality.)

CASE 3. G. Female, age 26. (1) General backache following a fall. (2) Some days later, pain over the left sacro-iliac area. (3) This was followed one week later by left posterior thigh pain. (Trauma.)

CASE 4. D. J. Male, age 41. (1) Pain in left lumbar area following a strain from lifting. (2) Suddenly, four days later, pain in the left sacro-iliac and gluteal areas and shortly thereafter pain in the posterior thigh. (Trauma.)

CASE 5. R. Male, age 35. (1) Pain midlumbar area, gradual onset. (2) Three days later pain in the left sacro-iliac area. (3) Somewhat later, pain in left posterior thigh. No trauma. (Static from an old fracture of the right leg three and one-half years previously.) Duration of symptoms, six months.

CASE 6. T. Male, age 26. (1) Sudden pain in the right gluteal area following a jump. (2) Ten days later sudden pain in right posterior thigh. (Trauma.)

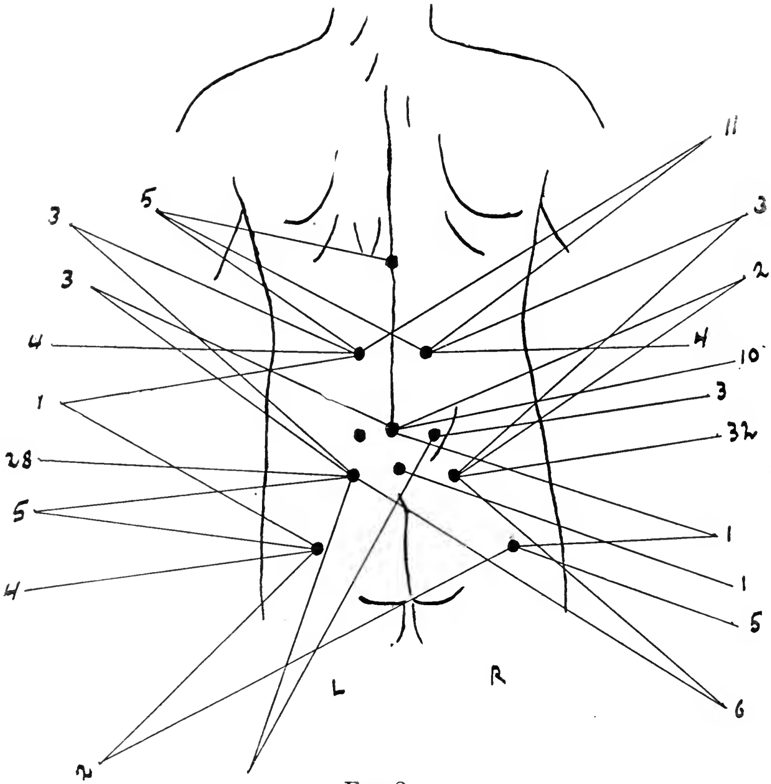

Fig. 2.

Case 7. G. Male, age 42. (1) Pain in right gluteal area after pulling hard. (2) Gradually, after four days, pain in posterior right thigh. (Strain.)

Case 8. M. Female, age 42. (1) Four months ago a bed fell on her left foot. (2) Ten hours later pain along outer aspect of left leg and posterior left thigh. (3) Shortly after this, lumbo-sacral pain. Sometime later this patient, a very intelligent woman, while sitting in a bath tub, found that flexing her left thigh with the leg extended, relieved the lumbo-sacral pain. She persisted in this exercise and states that this cured her lumbo-sacral pain. Her posterior thigh and leg pain, however, persisted. (Static?)

Case 9. K. Male, age 43. (1) Dull ache over the sacrum, gradual onset, no trauma. (2) Gradually, two weeks later, left posterior thigh pain. (Occupational strain?)

Case 10. M. Female, age 42. (1) Lumbar pain, gradual onset. (2) Two weeks later sudden posterior thigh pain. (Heavy, overhanging abdomen, very fleshy, static; chronic nephritis.)

Case 11. M. Male, age 29. (1) Sudden pain in left sacro-iliac area

followed immediately by pain in left posterior thigh, after lifting a piano. (Strain.)

Case 12. M. Male, age 32. (1) Lumbo-sacral pain, gradual onset five years ago. (2) One week later, gradual onset of pain in left posterior thigh and leg. At present, complete left paralytic drop-foot. So far as patient knows, the drop-foot has developed gradually. Lumbo-sacral pains persist. (Underground miner, static.)

Case 13. H. Male, age 45. (1) Chronic backache for many years, off and on at short intervals. (2) High lumbar pain, bilateral, suddenly, two months ago. (3) Disappearance of this lumbar pain for two weeks after a rest. (4) Sudden pain in the right sacro-iliac area and in posterior thigh. (Osteoarthritis of lumbar spine.)

For purposes of further analysis, the cases are separated into three groups according to the distribution of pain:

Group I. 59 cases, those with back pains only.

Group II. 140 cases, those with low back pains and posterior thigh and leg pains.

Group III. 14 cases, those with low back pains and pains distributed other than down the posterior thigh and leg. Five of these later cases are also included in Group II.

Table No. 2 shows the character of pain as noted in the case histories. Pain aggravated by turning in bed or by rising from the lying or sitting position, or by lifting, stooping or walking and relieved by lying down is noted under the heading, "Pain worse on movement." Pain aggravated when lying down or sitting still and better when moving or walking is noted under, "Pain worse when quiet." One woman claimed relief from a chronic low back pain only when pregnant.

Movement in the back or lower extremities was found limited in many cases. In many this limitation was only in flexion of the spine, extension being free. In others both movements were more or less limited. In others again, lateral movements were mostly affected. By placing the patient on his hands and knees,—"on all fours"—flexion and extension of the lumbar spine could be easily obtained in many, actively and passively, demonstrating the condition to be one of short or spastic muscles. In the definitely arthritic spines the movements remained limited under these same conditions.

When the thigh, with leg fully extended, was flexed at the hip, limitation of this movement was noted in many cases. In many it was accompanied by a pain in the posterior thigh and leg or in the lower back. Hyperextension of the thigh at the hip was also limited in many of these cases.

A strikingly flat back, or a backward curve in the lumbo-sacral area,

was noted in some of the cases. In others, again, there was present a definite list of the body to one side or the other.

Table No. 3 shows the relative absence and frequency of the above findings.

In twenty-eight cases of Group II, all of the above mentioned findings were present. In thirteen of this group there were no other signs than the localized back pain and tenderness and the posterior thigh and leg pain.

Findings having a bearing on the etiology of these cases are listed under various headings in Table No. 6.

1. Under static factors were listed the following when at all marked: a short leg on one side; old fractures of the lower extremities with malalignment; deformity of the feet; excessively fleshy persons with large pendulous bellies; and very manifest cases of general fatigue, weakness and anemia. There were also included four cases in which the x-ray showed a definite lipping on one side of the body of the 5th lumbar vertebra. In the absence of any previous injury or signs of infection, these were interpreted as being static in character.

Case 14. Mrs. B. Female, age 36. Short, fleshy, housewife. Duration of symptoms five months. No previous attack. No known trauma. Pain in the right sacro-iliac and in posterior right thigh and outer leg. Straight leg raising restricted and painful on both sides. Slight limitation of motion in the lower back. Trendelenburg phenomenon present on the right side. Marked degree of flaccid flat-foot and ankle valgus on both sides. X-ray examination of spine and pelvis negative. Both hip joints normal. Operation for hyperthyroidism one year previously. A well-fitting corset; shoe alterations and gradual exercises were followed by a gradual but steady improvement. See also Case 5.

2. Those cases were considered traumatic in which symptoms followed upon falls, direct blows or upon sudden strains from heavy lifting. Also cases in which symptoms followed suddenly upon slight movement and those cases in which x-ray gave evidence of trauma.

Case 15. Mrs. C. Female, age 45. Strong, large, and fleshy. Duration of symptoms one month. No previous attacks. Following immediately on a fall on left lower back, large hematoma over left sacro-iliac area. Pain and tenderness over left sacro-iliac area. Limitation of straight leg raising, left more than right. Lower back movements limited in all directions. Pain radiating down left posterior thigh; pain very severe and worse on slightest movement. X-ray examination negative. Treatment by heat, massage, and graduated active exercises. Litigation. Gradual improvement in four months.

CASE 16. T. Male, age 37. Teacher, tall, thin. Duration one day. Previous attacks five, ten, fifteen years ago. Began suddenly and was caused by bending over to pick something from floor. Sudden pain in the right sacro-iliac area and posterior thigh pains. Straight leg raising restricted and painful, lower back movements slightly restricted. A narrow belt around hips above trochanters gives instant, complete relief.

3. Infections were considered, when local and general signs pointing to an inflammatory lesion of osseous, ligamentous, muscle or joint structures were present. Included were cases following cold and exposure; those in which osteoarthritic changes were found in the vertebral or pelvic joints by x-ray.

Furthermore, infection was suspected in those cases where definite foci of infection (tonsils, teeth, genito-urinary, etc.) were present and in all cases with complete limitation of joint movement in all directions.

CASE 17. M. Male, age 12. Tall, thin boy. Duration of symptoms two weeks. Severe pain in lower back and left posterior thigh and leg. No previous attack. No trauma. Pain in the left sacro-iliac area. Straight leg raising very limited and causes pain in left sacro-iliac area. Back movements limited in all directions. Backward curve in lumbosacral area. Pain, tenderness, and swelling in lower, left lumbar area. A short time previously he had been operated upon for mastoid disease and this was later followed by sinus thrombosis, and a little later by the present low back symptoms. Draining of a small abscess of the left erector spinæ muscle caused prompt and permanent disappearance of symptoms.

CASE 18. J. M. Male, age 25. Medium size, short, muscular. Duration of symptoms one month. Began suddenly, worse at night and when lying down, more comfortable when up. No previous attacks, no injury. Pain, tenderness, swelling and increased local heat over right sacro-iliac area and down the right posterior thigh. Straight leg raising restricted and painful on the right side. Walks with a forward stoop and stands with a list of the body to the left. Was given one dose of morphine sulphate, large doses of sodium salicylate, local applications and bed rest. This was followed by prompt improvement within a few days.

CASE 19. W. Male, age 28. Medium build, thin, but fairly muscular. Pain very severe on movement in lumbar area to both sides. Duration two months. Previous attack three years ago. No trauma. Pain alternately in right and left posterior thigh. Movements of the lower back limited. Leucocyte count 10,000. X-ray shows osteoarthritis in the body of the 5th lumbar vertebra. Plaster of Paris jacket worn with relief for a time. This was followed by a modified Taylor brace. Patient later went elsewhere and had a bone graft inserted into the

lower back. Improvement was slow when last seen about eight months after the bonegraft operation.

4. Cases following pelvic disease in women, or after operation for pelvic troubles, and those associated with pregnancy or parturition, are classed as gynecologic.

Case 20. Mrs. F. Female, age 35. Married, music teacher, large frame, muscular, poorly nourished. History of many miscarriages. Pain and tenderness over both sacro-iliac areas with posterior thigh and leg pains for a long time and more or less steady. No trauma. No restriction of motion or pain on straight leg raising. No limitation of movement in the back. No deformity or deviation of body. States that she is free from these pains only when she is pregnant. Pelvic examination negative, Wassermann negative. Marked improvement after wearing properly fitting corset and a short course of anti-luetic treatment.

5. Five cases were associated with demonstrable nerve lesions.

Two cases had paralytic drop-foot (see Case 12), one of these following a severe injury with traumatic lesion in the 5th lumbar vertebra. One case (spina bifida) of mild paralytic pes equino-varus. One case had recurrent attacks of sudden pain and blanching in each great toe. One case with recurrent attacks of stiffness and pain in the lumbar area and with pain and weakness in both posterior thighs very much resembling an infectious arthritis. Symptoms of transverse myelitis of the cord gradually developed. At operation this proved to be a cystic (hemorrhagic) degeneration below the lumbar enlargement of the cord.

6. In five cases malignancy was considered as the probable cause. In one case (M., age 49, operated upon for carcinoma of the stomach one year previously) symptoms of pain and tenderness in the right lower back and opposite the right 5th lumbar transverse process, and in the left sacro-iliac area, and pain in the left posterior thigh of eight weeks' duration became progressively worse and death from metastases followed two months later. In a similar case the symptoms followed nine months after an operation for carcinoma of the breast, and continued progressively until death eight months later. In one, symptoms began some time after operation for suspected malignancy (ovarian tumor) and became progressively worse while the patient was under observation. The patient was later lost sight of. In two other cases the symptoms were those of marked osteoarthritis of the lumbar spine. In one of these the x-ray was typical of an extensive osteoarthritis but the patient became progressively worse and died of metastases ten months

later (sarcoma). In the other case death occurred, after symptoms had progressed steadily, in four months (no autopsy.)

7. Of the cases in which lues was a possible factor (history or positive Wassermann) two are given.

CASE 21. Mrs. V. Female, age 25. Married, housewife, large, strong, muscular. A fall off a step one year previously was followed by pain in the posterior left thigh and pain and tenderness in the right lower abdomen. (Appendectomy had been performed some two months before for this pain.) Similar attack some years previously. Straight leg raising was restricted and painful. Lower back movements free. Indication of Trendelenburg phenomenon on the right side; atrophy in the left calf. Wassermann 4+ repeatedly. X-ray examination was negative. Vigorous anti-luetic treatment was without effect.

CASE 22. M. Male, age 40. Married, salesman, large, fleshy, hypopituitary type. Five months ago pain gradually developed in the left gluteal area and extended down the posterior left thigh. No injury. No previous attacks. Fifteen years ago, chancre. Pain severe and continuous; worse on movement. Straight leg raising very limited and painful on both sides. No limitation of lower back (joint) movement, marked list of body to the right. Reflexes, inclusive of pupillary, normal. No pathological reflexes. Both lower extremities normal. Very apprehensive mental state. Blood Wassermann negative. Spinal fluid: cell count 11, Wassermann 3+, no globulin. Short anti-luetic treatment without any effect. Three weeks later, suicide.

8. Tuberculosis was a positive factor in two cases.

CASE 23. Mrs. J. Female, age 31. Tall, very emaciated. Pain and tenderness in the right sacro-iliac area and in the right posterior thigh. Began gradually four weeks ago. No previous attacks. No trauma. Straight leg raising limited on the right side. All movements of the lower back absent. Walks stooped forward. No deviation of body to the side. Trendelenburg phenomenon present on the right side. Walking and coughing causes pain over the sacro-iliac area. A soft swelling over the right sacro-iliac area. Active pulmonary tuberculosis. X-ray shows destruction at the right sacro-iliac joint.

CASE 24. R. Male, age 23. Gradual onset two months ago with symptoms of low lumbar pain of an indefinite character. Moderate limitation of movement of the lower back. Negative x-ray (Group 1). There appeared eight months later a large lumbar abscess showing the true nature of the process which had not been suspected.

X-ray examinations were made in all but thirty-four cases. In most cases the plates were found to be negative. Positive findings were noted as follows: Osteoarthritis of the lumbar spine, ten cases (seven in Group II); arthritic changes (lipping) in body of 5th lumbar vertebra,

nine cases (eight in Group II); anomaly of transverse processes of fifth lumbar vertebra, nine cases (five in Group II); spina bifida occulta, one case (Group II); arthritic change in one sacro-iliac joint (lipping of lower edge) in one case (Group II); and a roughening or spur formation on one iliac crest, one case (Group I). In three cases of Group II there was present an apparent widening of the sacro-iliac joint of one side. In one case (Group I) there was present a tear fracture of the end of the transverse process of the first lumbar vertebra.

Anomalies of the transverse process of the 5th lumbar vertebra included clubbing, sacralization, and impingement of the process. The following are brief case reports of these.

Case 25. D. Male, age 38. Troubled off and on for three years. Pain in the right and left sacro-iliac areas. No posterior leg pains. Clubbed 5th lumbar transverse process.

Case 26. R. Female, age 34. Four days' duration, similar attack two years ago. Present symptoms brought on by a very slight movement, reaching for something. Pain over the fifth right lumbar transverse process. Very free leg movements. Flexion and extension of the lower back limited. Pain constant, severe, on slightest movement. Enlarged right transverse process. This patient was very short and fleshy.

Case 27. S. Female, age 23. Duration four years. Began gradually, following birth of last baby. Lumbo-sacral pain. Appendix removed for this trouble a short time ago. Very fleshy. Steady pain day and night, worse on walking. No muscle spasm. Left 5th lumbar transverse process clubbed with articular facet for sacrum.

Case 28. P. Female, age 26. Tall, stooped, thin, enteroptotic. Many miscarriages. Lower backache. No limitation of straight leg raising. Movement limited in left lower back. Back flat. Body list to the left. Flexion causes prominence in left lower back. Flat-foot. Splay foot. Feet functioned well. Pelvis negative. Wassermann negative. Sacralized 5th left lumbar transverse process.

Case 29. Female, age 33. Tall, thin, bony, poorly nourished. Six months' duration. Previous attack ten years ago. No trauma. Pain in left lower back. No limitation of straight leg raising. No symptoms of muscle spasm. Pelvic operation some years ago. At times lying down aggravates the trouble. Impingement of the left 5th lumbar transverse process.

Case 30. C. Male, age 39. Three months' duration. No previous attack. No trauma. Trouble followed cold and exposure. Pain in the right sacro-iliac area. Limitation of straight leg raising on the

right. Back movements limited. List to the left. Sacralized 5th right lumbar transverse process.

CASE 31. P. Male, age 31. Tall and muscular. Two months' duration. Pain in the right and left sacro-iliac areas. Posterior thigh pains right and left alternately. Straight leg raising limited, right and left. Back movements limited. Flat back. Very marked list to left. No trauma. Prompt relief followed Buck's extension and plaster jacket. Enlarged 5th lumbar transverse process. (Six months later appendix removed.)

CASE 32. W. Female, age 38. Duration twelve years "most all the time." A direct injury fourteen years previously in which the coccyx was traumatised. Pains in the lumbo-sacral and left sacro-iliac areas. No limitation of straight leg raising. Back limited in flexion only. Deformed coccyx could be felt. A large club-shaped 5th lumbar transverse process right and left. Coccyx removed under local anesthetic. Complete immediate relief. No other treatment.

CASE 33. K. Male, age 34. Duration three months. Similar attack seven years ago. Sudden onset, no injury. Pain in the sacro-iliac area, the right worse than the left. Limitation of back movement. Tall and muscular. Sacralized 5th lumbar transverse process on the right side.

The following are other cases in which abnormalities were noted on radiographic examination.

CASE 34. C. Male, age 40. Medium size and build, poorly nourished and poor general musculature. Duration of symptoms four weeks. No previous attack. Began suddenly with no known trauma. Low lumbar back pain. Straight leg raising much limited on the right side and some pain over the area of the right 5th lumbar transverse process. Back movements all limited. Walks with a forward stoop. Recent acute attack of tonsillitis. X-ray examination shows spur formation on the right iliac crest. A few days later man returned stating that immediately after the examination his symptoms left him. No sudden phenomenon was noted by him during the examination. He has remained well since.

CASE 35. L. Male, age 30. Tall, muscular. Pain and tenderness over the right sacro-iliac area, six months' duration. Began gradually following a tonsillar abscess. Had an attack much like the present one some years ago. No trauma. Straight leg raising limited on the right side. Lower back movements all limited. Marked list of body to the left. Tonsils pathological. X-ray examination shows definite lipping of the lower edge of the right sacro-iliac joint. Case not followed.

Treatment of these cases was carried out by various means: 138 were treated by some form of mechanical support (pelvic and back braces, abdominal supports, corsets, canvas belts, and plaster jackets); 25 by correction of static abnormalities in the feet (shoe alterations); 18 by hyperflexing, under general anesthesia, the extended leg and thigh on the abdomen; 17 by leg extension (weight and pulley). In a few other cases bed rest and internal medication were used. In one, an abscess on a lumbar muscle was drained and in three a dislocated coccyx was removed (Case 32). All cases, except those definitely arthritic, were given active exercises for the back and lower extremities.

Improvement was at times very rapid and pronounced. This was especially true of all cases after forcible manipulation under ether, and twice by simple manipulation during examination. At other times the application of a simple strap above the trochanters, or a low, snug fitting corset or brace, gave relief no less prompt and complete.

In two cases, after forcible manipulation under ether, there followed no relief (one a probably malignant ovarian tumor, the other was later found to have osteoarthritis demonstrable by x-ray). In two other cases improvement was gradual and slow. In some cases treated in this manner there was noted a soft tearing (like tearing tissue paper), in others there was felt a sudden thud and a giving away of something.

These phenomena were usually followed by considerable local soreness, swelling, and ecchymosis in the posterior thigh. In two cases there was a sudden recurrence of the acute symptoms after a period of complete relief. In such instances the recurrence was brought on by a slight movement in leaning forward.

In most cases the improvement was very slow and gradual. In about 25% of all cases the patients were lost from observation after a short time and the improvement, therefore, not known. In ten, there was noted no improvement.

Death occurred in six cases, four were from malignant growths, one was from tuberculous meningitis and one was from degenerative spinal cord lesion.

COMMENT.

The proportion of males to females is nearly two to one (Table No. 4). This is probably not a true proportion, because, as stated before, there were examined many women (belonging mostly to Group I) of whom no records are available.*

*These comprise a series of cases, occurring in the practice of a gynecologist, in which the pelvic examination was negative.

GROUP	Pain worse when up, moving or lifting.	Pain worse when quiet, better when walking, etc.	Pain constant or severe.	Worse nights or early in the morning.	Worse in afternoon.	Cases not noted.
I	16	9	6	4	4	18
II	57	11	14	13	2	41
III	3	1	0	3	0	6
TOTAL	76	21	20	20	6	65

TABLE No. 2.

The cases were separated into groups because of symptoms only. Cases in Group II were generally more severe than those in Group I. In this series the males predominate in all groups. The greater chronicity in Group I is probably due to the relatively greater number of traumatic cases in Group II and because the cases in this latter group were of a more severe character, and therefore sought relief earlier. The physical characteristics of cases as noted in Table No. 5 show a very close parallel between Groups I and II. There is nothing noteworthy in the character of the pain (Table No. 2). It runs fairly parallel in Groups I and II. In most cases it is worse on movement. Relative to the location of pain (Table No. 1), it will be noted it lies in the area occupied by the erector spinæ group of muscles (origin, body, and insertion), 196 times in 220. The most frequent site is the sacroiliac area, especially in Group II. Study of the cases here given shows that there is nothing typical in the site of the pain, which would enable one to locate a lesion accurately. At times it was definitely shown that the lesion was at some other point.

It is interesting to note the sequence of the pain as given in Cases 1 to 13. These show the successive involvement of groups of muscles until several groups of one system of muscles have been involved. Very interesting in this connection is Case 8, in which the pain and limitation of movement extended upward, and not downward, as occurred in all other cases. This woman, after sustaining an injury to a foot in the forenoon, walked much while shopping all the afternoon, and

GROUP	Lim. of movt. in lower back. No	Yes	Lim. of str. leg raising. No	Yes	Flat back, backward curv. lower back. No	Yes	Body List. No	Yes
I	39	15	42	7	43	3	42	2*
II	38	84	35	93	61	39	72	39**
III	5	7	9	2	8	5	11	3
TOTAL	82	106	86	102	112	47	125	44

* Once toward the painful side.

** 4 times toward the painful side.

TABLE No. 3.

felt the pain in the posterior thigh come on ten hours after the primary injury.

In Table No. 3 it will be noted that there is a definite parallel between cases having limitation of lower back movement and those having limitation of straight leg raising, and between these cases and those with posterior thigh pains (Group II). The occurrence of flat back and backward curve, as well as of the list of the body to one side, is characteristic of Group II. All positive findings in Table No. 3 are manifestations of muscle spasm or of muscle shortening. They were present under varying conditions and their presence gave no clue to the underlying cause (*e. g.* traumatic, infectious, static).

The association of posterior thigh pains with low back pains is well known. These pains are often spoken of as being sciatic in origin. The list of the body to one side which is frequently found in these cases has been called sciatic scoliosis, the list or "scoliosis" being considered secondary to the sciatic pain.

The posterior thigh pains, while very suggestive of a sciatic nerve distribution, in nearly all cases, give positive evidence of sciatic origin in only very few cases—(Case 12 and four others briefly noted on page 360 *ff*). Of these cases, Case 12 is the only one not associated with a severe traumatic lesion of the lower spine or with a primary nerve or cord lesion. A few other cases complained of paresthesia on the outer aspect of a leg or foot, but in these there was no objective sign of nerve lesion. In only thirteen cases of the whole series in which these posterior thigh pains were present, was an absence of muscle spasm noted.

GROUP	Males	Females	Duration to date	Previous attacks		Trauma		Associated with childbirth.
				Yes	No	Yes	No	
I	36	23	27 mos. (53 cases)	18	31	15	27	5
II	96	44	11½ mos. (121 cases)	57	63	55	44	0
III	(9)* 6	(5)** 3	10 mos.	5	6	5	6	1
TOTAL	138	70		80	100	75	77	6

* 3 counted twice.

** 2 counted twice

TABLE NO. 4.

Bilateral leg pains in cases with osteoarthritis were undoubtedly of nerve root origin. Case 22 may have been one of cord lesion.

In the greatest number of cases these leg pains followed after all other symptoms (muscle spasm) had put in their appearance, and were relieved as these other symptoms disappeared. In many cases the hamstring muscles were often noted as being tender on palpation.

GROUP	Tall or short but muscular and strong.	Fleshy, overweight.	Thin, but wiry.	Tall, thin and weakly.
I	21	15	2	13
II	66	35	5	12
III	6	5	0	2
TOTAL	93	55	7	27

TABLE NO. 5.

GROUP	Static	Traumatic	Infectious	Gynecologic	Neurologic	Malignant growths	Lues	Tuberculosis	Congenital anomaly
I	26	2	11	2		0	1	1	0
II	30	24	20	7	5	5	4	1	1
III	6* 4	1	2	0		2*	0	0	0
TOTAL	60	27	33	9	5	5	5	2	1

* 2 counted twice.

TABLE No. 6.

Reference to Table No. 6 shows that in one hundred and forty-seven cases in which the records were complete, over 80% are classed as static, traumatic, or infectious in origin. Of these, over one-half are classed as static, and the other half nearly evenly divided between the traumatic and the infectious.

The static group, in the writer's opinion, is probably greater than here stated. Thus, most cases classed as gynecologic and obstetric are really static in origin and nature. In a severe case, manifesting all the typical symptoms that have been discussed, one may elicit a history somewhat as follows: From the sixth month of pregnancy on, a more or less gradual but insistent low backache followed by posterior thigh and leg pains; parturition follows normally and the pains improve and disappear; two weeks later the new mother leaves her bed, and after a further two weeks the nurse is discharged and the mother takes over the care of the baby with all the bending over and stooping forward which such care demands. The symptoms all gradually develop anew. During the latter months of pregnancy the posterior back musculature is overtaxed by the rapidly increasing anterior load, and is not functionally fit to cope with the new demands made upon it. In Case 14 the previous hyperthyroidism probably played an important rôle in weakening musculature to a considerable degree. The term "insufficientia vertebrae" is very apt. It is probable that not a few individuals go through life handicapped by this condition. About 44% of all cases give a history of previous attacks (Table No. 4).

While trauma was given by the patient as a cause in about one-half of the cases, it was considered to be the chief cause in a little over 18% (Table No. 6). Nearly all cases belonged to Group II. It is possible, as Lovett suggested, that cases following very slight trauma may be really arthritic. In the absence of positive x-ray evidence, there is nothing to indicate the exact site of injury, or the tissues injured.

In this series there was no case which the writer felt was due to sacro-iliac relaxation or subluxation. If, following muscle insufficiency (as in weak foot), the strain is thrown upon ligamentous structures, there would follow a strain not only in the sacro-iliac structures, but also in the structures of other joints equally involved. It is probable that this occurs frequently. (Insufficientia vertebræ.)

The frequency of anomalies of the 5th lumbar transverse processes has been variously estimated. Thus, Nové-Josserand and Rendu[1] in four hundred cases in which x-rays were made at random, found such anomalies present in 7 or 1.7%. In eight hundred cases with lumbar pains, they believe the symptoms might be attributed to the anomaly in twenty-two, or 2.7%. In the two hundred and eight cases of this series they were present in more than 4.3%.

In the nine cases (25 to 33) there is none, except possibly Case 26, in which the symptoms can, with any degree of probability, be attributed directly to such an abnormality. The symptoms in Case 32 certainly had nothing to do with the anomaly which existed.

Cases in which the arthritic manifestations are slight, are difficult of detection. It is probable that these cases are the ones most chronic and most subject to recurring attacks.

Cases in which lues was suspected were uninfluenced by anti-luetic treatment, and were undoubtedly of other etiology. Case 22 may have been one of beginning spinal cord lues. Aside from the very meagre findings in the spinal fluid there was nothing in the case to distinguish it from other typical cases of other etiology. Kennedy and Elsberg,[2] in discussing "a peculiar undescribed disease of the nerves of the cauda equina," refer to cases which, in their beginning, are very similar clinically to many of the cases in this series, and which later show definite muscular and sensory changes in the lower extremities. At operation in these cases an inflammatory condition of the cauda equina was found.

The case referred to on page 361 is very suggestive of this condition: a young man, age 32, was seized with a severe pain in the lower lumbar and lumbo-sacral region. He attributed this to a drenching after a hard day in the woods. The severity of the pain persisted for two days.

The pain was worse when he was sitting or lying down, and better on walking; gradually it extended to the legs and feet, continuing so for three weeks. During the next month he worked little; there was a tendency to fall easily. Two months after the first symptoms he became chilled again. A dull ache throughout the lower back and legs followed this. He could get no relief and was unable to work. From the beginning of his trouble his bowels were constipated and he had difficulty in passing water. Two months after the onset the patient was seen by an associate during the writer's absence in the service. At this time there were no positive neurologic findings. Two and a half years later the man came under observation again, this time with symptoms of a rapidly progressing transverse cord lesion.

Tuberculosis, because of its relative frequency in the lower back, its chronicity and its insidiousness, should always be kept in mind. Had more attention been paid to the previous history and to certain other apparently minor factors, a disastrous result in Case 24 might have been averted.

Cases of this series occurring in the presence of growths of known malignancy, and in which the symptoms are continuous and progressive, and uninfluenced by treatment have, except one which was lost from observation, all ended in death. In one, the malignant feature was only suspected, in another (radiographic signs of typical osteoarthritis) the true nature was unsuspected until the appearance of metastases.

The sudden relief which was experienced in some cases by a slight movement, or by a forcible manipulation is, in the writer's opinion, comparable to the sudden relief experienced in stiff and painful shoulders after similar movements or manipulations. In these shoulders the lesion is generally periarticular and the improvement dependent upon the breaking up of the adhesions. In stretching some of these legs under anesthesia there was noted a sensation of tearing which suggested very strongly the presence of adhesions somewhere at or above the insertion of the hamstring muscles. In several cases which suddenly gave away with a thud the writer imagined the phenomenon depended possibly upon the bursting of a distended sac (bursitis). The force used in these cases was certainly not enough to tear a large muscle from its attachment.

In many cases the improvement was slow, and in many who were lost from observation the progress was probably not satisfactory. In some cases there is a strong neurotic tendency and in these the recovery is notoriously unsatisfactory. The same is true in cases with damage suits pending and compensation claims to settle.

CONCLUSIONS.

1. Any injury or disease affecting the lower back structures (muscular, ligamentous, bursal, osseous or joint) may give rise to a similar symptom complex in cases of chronic low back pains.

2. Unfavorable static conditions in the lower back or extremities resulting from abnormalities in the lower extremities, postural or occupational strains, or from fatigue or weakness, frequently exist in these cases and operate as a cause in the production of symptoms either alone or in conjunction with other causes.

3. In all cases of low back pain, the possibility of a progressive disease of the spine or of the spinal cord should be kept in mind.

4. The best results from treatment were obtained in cases in which static abnormalities were corrected, in which lower back structures were protected or put at rest, and in which such structures, if shortened, were stretched.

5. Graduated systematic exercises are an important adjunct in the treatment of many of these cases.

REFERENCES.

1. Presse Méd., July 20, 1920. Abstracted in Practical Medicine Series, vol. iv, series 1920. The Year Book Publishers, Chicago.
2. The American Journal of the Medical Sciences, May, 1914, No. 506, vol. cxlvii, No. 5, p. 646.

SIMULTANEOUS HYDROPS OF THE KNEES.

BY HENRY J. FITZ-SIMMONS, M.D., BOSTON, MASS.

Bilateral swelling of the knees, coming at the same time or closely enough to be practically at the same time, is rather uncommon. In this paper, a clinical analysis has been made and cases tabulated, in an attempt to find common factors. In examining the records of a large hospital clinic, it was possible to find but thirteen cases which could be classed as hydrops simultaneously observed in both knees. These cases were taken from a clinic which admits only children under thirteen. The clinical study was begun with the idea of placing the proper diagnostic value on this type of knee swelling.

There are certain factors in examining such cases which must be kept in mind. These have been used in this study as the framework upon which to base a clinical diagnosis. They are:

What was the first symptom noted?—whether pain, swelling, heat, redness, or functional disability.

Was this first symptom preceded by any infectious condition or trauma; or had a similar condition ever previously been noted in the joints under observation, or in any other joints?

Have the joints shown improvement at any time? Have there been remissions in severity of pain?

The family history of the patient may give added information concerning an inherited taint. The health of the parents at the present time and previous to the birth of the patient may be of great value.

The maternal history as regards miscarriages and, if any, when they occurred with reference to the birth of the patient. The health of the present living brothers and sisters must be gone into in detail in regard to systemic constitutional ailments. The cause of death of any children should also be known in as great detail as possible.

The history of the patient from the time of birth, in relation to nursing, prevalence of colds, or the presence of lowered resistance, should be noted.

The course and progress of the condition under treatment should also be noted.

The physical examination should discover the presence or absence of syphilitic stigmata, as well as the more evident manifestations of pathology.

TABLE 1.

ELEVEN CASES OF SYMMETRICAL SYNOVITIS OF THE KNEE.

No.	Sex.	Age.	Joints.	Duration of symptoms.	Evidence of hereditary syphilis.	Family history.
1	M.	10	Both knees.	4 months.	Double interstitial keratitis; typical teeth; ostitis of both tibiæ.	No notes.
2	F.	8	Both knees.	6 months.	Double interstitial keratitis; ostitis of one tibia.	No history.
3	M.	11	Both knees.	6 weeks, and then ceased attending.	One typical central incisor; nodes on tibiæ; snuffles and skin eruptions in infancy.	Mother had two stillborn children before patient.
4	F.	9	Both knees.	3 months.	Interstitial keratitis of one eye of two weeks' standing, with no further notes; one typical central incisor.	No history.
5	F.	20	Both knees (two years apart).	6 months each.	Remains of double interstitial keratitis; ostitis of both tibiæ, which are very large.	No history.
6	F.	10	Both knees.	7 months.	Double interstitial keratitis; typical teeth.	Father syphilitic; no evidence in family beyond patient.
7	F.	15	Both knees, and right articular tenderness.	6 months.	Double interstitial keratitis under Mr. Nettleship; incurable deafness of one month's standing.	No history.
8	M.	14	Both knees, articular tenderness.	3 months.	Interstitial keratitis; typical teeth; deaf.	No notes.
9	M.	12	Both knees.	2 months, and probably more.	Interstitial keratitis.	Well-marked history of mother being infected, and then having miscarriages.
10	F.	8	Both knees acute and painful one week after fall on knees. One joint tapped. Recovered with good joints.	4 months.	Double interstitial keratitis.	Doubtful history.
11	M.	21	Both knees. History also of both ankles having been swollen at commencement.	12 months.	Double interstitial keratitis for nine months; still under observation.	Patient is third child; fourth, fifth, sixth, and seventh children died in infancy; eighth under observation for interstitial keratitis.

TABLE 2
TUBERCULOUS

Name	J. G.	M. S.	F. S.	G. B.
Age	3	5	2	8
Duration at first examination	18 mos.	12 mos.	3 weeks	2 mos.
First symptom noted	Swelling	Swelling and pain	Swelling and pain	Swelling
Onset	Acute-non traumatic	Insidious	Gradual	Insidious
Fever at onset	Yes	No	Yes	Yes
Constitutional symptoms	None	None	None	Weakness
Other joints involved	None	Ankle	Hip and spine later	None
Swelling at first examination	No	Yes	Yes	Yes
Surface temperature	Yes	Yes	Yes	No
Increase of fluid in joint	No	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes	Yes
Bony thickness	Yes	Yes	Yes	No
Atrophy above joint	Yes	Yes	Yes	Yes
Motion	Markedly limited	Markedly limited	Markedly limited	Limited
X-ray evidence of tuberculosis	Squaring of condyles	Squaring of condyles	Squaring of condyles. Bone atrophy of size and substance	Not obtained

TABLE 4
POSITIVE SYPHILITIC

Name	H. L.	N. R.	J. N.	W. Y.
Age	8 2/3	6	10	3 3/12
Duration at first examination	30 mos.	3 mos.	3 weeks	3 mos.
First symptom noted	Pain and swelling—night	Swelling and pain—night	Swelling	Swelling
Onset	Insidious	Insidious	Insidious	Insidious
Fever at onset	No	No	No	No
Constitutional symptoms	Weakness	Weakness	Weakness	Weakness
Other joints involved	Ankles	None	None	None
Swelling at first examination	Yes	Yes	Yes	Yes
Surface temperature	Slight	No	No	No
Increase of fluid in joint	Yes	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes	Yes
Bony thickness	Yes	Yes	Yes	Yes
Atrophy above joint	Yes	No	Yes	No
Motion	Very slightly limited	Very slightly limited	Very slightly limited	Very slightly limited
Von Pirquet	Negative	Negative	Negative	Not obtained
Wassermann	Doubtful	Doubtful	Triple plus	Not obtained
Evidences of syphilis	X-ray appearances (Father acknowledges lesion)	X-ray appearances. Indolent ulcer on leg	X-ray appearances. Interstitial keratitis	X-ray appearances. Ulcer on leg. Perforation of palate

TABLE 4-A
SUSPECTED SYPHILITIC

Name	W. St. G.	S.	E. O.
Age	2	9	7 years, 10 mos.
Duration at first examination	3 months	12 months	5 years
First symptom noted	Swelling and deformity	Pain and swelling—night	Pain and swelling
Onset	Acute	Three days after accident	Not known
Fever at onset	No	No	Yes
Constitutional symptoms	None	None	Delicate
Other joints involved	None	None	None
Swelling at first examination	Yes	Yes	Yes
Surface temperature	No	No	Slight
Increase of fluid in joint	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes
Bony thickness	Yes	No	Yes
Atrophy above joint	Yes	No	Yes
Motion	Limited	Slightly limited	Limited
Evidence of syphilis	X-ray appearances	Two miscarriages	

TABLE 3

NON TUBERCULOUS, NON SYPHILITIC INFECTIOUS

Name	F. W.	J. P.
Age	12	8
Duration at first examination	7 months	4 years
First symptom noted	Pain in hip. Swelling in knee	Swelling
Onset	Acute	Acute
Fever at onset	Yes	Yes
Constitutional symptoms	Systolic murmur	None
Other joints involved	None	Wrist
Swelling at first examination	Yes	Yes
Surface temperature	Yes	Yes
Increase in fluid in joint	Yes	Yes
Increase in circumference of joint	Yes	Yes
Bony thickness	No	Yes
Atrophy above joint	No	Yes
Motion	Limited	Limited

In the local examination, should be noted signs of inflammation about the knee. Bony should be differentiated from capsular thickening. The motions should be tested in comparison with the normal.

In this series of thirteen cases, it has been thought rational, owing to the time which elapsed during the first observation and the last, to classify them clinically into three groups. The first group, which contains four cases, were considered tuberculous (Table 2). The two cases in the second group were of an infectious nature, but were not considered to be tuberculous or syphilitic (Table 3). The remaining seven cases, four of which were considered syphilitic and three probably syphilitic, have been grouped together (Tables 4 and 4a).

In those that were considered tuberculous, the average age was four years and six months. The duration of the symptoms, previous to the first examination, averaged about eight months, the longest having gone eighteen months with symptoms of such a benign nature as not to necessitate a hospital visit. The shortest duration of symptoms before the first examination was three weeks. All these cases noted swelling as the first indication of trouble, and in two cases this swelling was accompanied with pain. In one case, the onset of the symptoms was very acute, and in the remaining three, insidious. Fever accompanied the onset of the symptoms in three cases and was absent in one. None of these cases, with the exception of the one that I have marked "G. B.," showed any constitutional symptoms in the beginning. The knees were the only joints affected in two cases; and in the other two cases the knees were followed, by the ankle in one, and the hip and spine in the other. All four cases showed in the beginning a marked surface temperature at the knees, with an increase of fluid in the joints in all but one case,

which later developed fluid. Naturally there was also a marked increase in the circumference of the joints. There was bony thickening in three cases, but in the one marked G. B., "suspected tuberculous," this bony thickening was absent. Atrophy in the lower end of the femur and the lower leg was a constant symptom in all cases, with motion markedly limited in all from the beginning.

In Table 3 are shown two cases which differ from those considered tuberculous or syphilitic in that pain, as well as swelling, was a beginning symptom; that the onset was acute; that fever was present; and that in one case constitutional symptoms and a heart lesion were present, although there were no marked constitutional symptoms in the other. In one case, the infection was confined to the knees solely, while in the other, an infection in the wrist complicated the original infection. Surface temperature, increase of fluid in the joints, and increase in the circumference of the joints were constantly present in both cases. Atrophy and bony thickening were present in one and absent in the other, while motion was limited in both from the beginning.

Tables 4 and 4a show the findings in the syphilitic or suspected syphilitic cases. The average age was almost seven years, which is considerably older than in the other cases. The average time of duration varied from five years to three weeks. With the exception of the two extremes, it averaged about ten months before the symptoms caused the patients to be brought for examination. Of the cases that were considered positively syphilitic, pain and swelling were present in two, and swelling alone in two, without pain. In the cases in which pain was present, this pain was worse at night. The onset in each case of this group was insidious. At no time was there fever, and all showed evidences of constitutional weakness. In three of the cases, the knees alone were infected, and in one case, the knees and ankles. No surface temperature was present except in one case where it was very slight. An increase of fluid and an increase in circumference at the joints were found in every case. Bony thickening was absent in three of the cases and present in one, while atrophy was present in two and absent in two. Motion was free, or only slightly limited, in all. In Tables 4 and 4a, swelling was observed in all, while pain was observed in two, one of these cases showing marked pain at night. The onset of the symptoms was acute in two cases, and not known in the other. Fever was absent in two and present in one. At the onset of the trouble, no constitutional symptoms were noticed. The knees were the only joints affected and showed swelling, increase of joint fluid, increase in joint circumference. There was absence of surface tem-

perature in two cases and slight surface temperature in one. Bony thickening and atrophy were present in two and absent in one. Motion was limited in two, and slightly limited in one.

An interesting clinical point noted in the comparison of those considered tuberculous with those considered syphilitic was that pain, as a symptom early observed, was slightly more prevalent in the former. The onset in both groups was, as a rule, insidious or gradual. Fever was present more frequently in the tuberculous group than in the syphilitic. The constitutional symptoms, as expressed by general weakness and tire, were earlier observed and more constant in the syphilitic than in the tuberculous group. Other joints in this condition seemed to be involved more frequently among the tuberculous cases than among the syphilitic. Surface temperature, bony thickening, and the limitation of motion were all more marked in the tuberculous than in the syphilitic. The expression of a more rapidly destructive process was evidenced more in the tuberculous than in the syphilitic group.

Only in the cases enumerated in Table 3 was there any infectious or recent traumatic factor which preceded the onset of the symptoms. In a small proportion of the total number of cases listed under Table 2 there was a vague history of a similar condition in the past involving the knee joints. The joints have also, in this tuberculous group, shown remissions in severity during the progress of the disease. The family histories of the cases on Table 4 showed, in two instances, presence of miscarriages and other syphilitic stigmata, and also the same conditions were observed in two cases that were considered tuberculous. The health of the present living brothers and sisters offered no increase in knowledge, nor did the cause of death of other children in the families of these patients offer definite data upon which to hazard suspicion. The thirteen cases under observation all had the benefit of maternal nursing, so, it is fair to presume, started life without the handicap of artificial feeding. The final clinical test of the progress of the condition under treatment showed that the cases marked "positive and suspected syphilitic" were all improved under the use of mercury and iodide. Those considered non-syphilitic did not so improve, but did respond, as non-specific joints do, to appropriate treatment of fixation and general hygiene.

The knees in group three (Tables 4 and 4a) differed from those in the other groups. They seemed full, but not tense, and gave a feeling of soft fluctuation on palpation. The bones, entering into the formation of the joints, were not enlarged, and the roentgenographic appearances showed no atrophy nor definite destruction of joint surfaces.

This lack of destruction and the chronicity of the synovitis, with ultimate excellent functional result, is characteristic of the syphilitic joints, and not of the others.

Mr. H. H. Clutton, in the *Lancet* of February 27, 1886, page 391, states that he believes symmetrical synovitis of the knee is due to hereditary syphilis and always shows evidence, either past or present, of the diseases. In his cases, shown in Table 1, the predominant features were symmetry of the affection, freedom from pain, the long duration of the symptoms, and the free mobility of the joints on passive motion throughout the course of the disease. A summary of his belief is included in this statement, "I have never seen both knee joints filled with fluid, causing scarcely any pain or discomfort, whilst other joints remain free from any signs of inflammation, except in cases where there was distinct evidence, past or present, of hereditary syphilis."

Dr. Abner Post in the *Boston Medical and Surgical Journal* of December 23, 1915, vol. clxxiii, No. 26, in an article on "Symmetrical Synovitis in Hereditary Syphilis," draws the same conclusions.

Conclusions: From the analysis of the thirteen cases studied, it must be concluded that symmetrical synovitis of the knee may be due to tuberculosis, trauma, or some infectious agency of a non-tubercular or non-syphilitic nature. However, symmetrical synovitis of the knee, chronic in nature, free from marked discomfort, and without bony thickening, which permits almost painless motion of the joints during the course of the disease, and an ultimate excellent functional result, is due probably to hereditary syphilis.

LOW BACK PAIN—A CLINICAL STUDY OF ITS CAUSE.

BY JOHN TOLSON O'FERRALL, M.D., NEW ORLEANS, LOUISIANA.

THE Orthopedic Clinic of the Touro Infirmary offers great opportunity for the study of low back pain, because of the large number of laborers applying for treatment. The author fully realizes the great diversity of opinion existing in regard to the cause for such conditions, and with this fact in mind, a review of forty recent cases has been attempted.

In my opinion, this condition has been approached, in the past, with such great respect for the severity of the condition, that the true clinical facts have been overlooked, and preconceived ideas of the parts involved have overshadowed the real anatomy of the lumbo-sacral region. This is almost entirely true of the general practitioner and the general surgeon.

A brief résumé of the anatomy of the lumbo-sacral joint will indicate, primarily, that we are dealing with a very unstable structure. "The lumbo-sacral articulation in its main part inclines downward and forward,—about thirty degrees when the person is standing erect, and except for the articular processes at the back, the spine would naturally slide forward upon the sacrum. The ligaments under normal conditions represent considerable support, but they would naturally be stretched in a short time and displacement of the bones take place, except for these articular processes. The lumbo-sacral joint is capable of considerable motion, fully one-half of the motion of the trunk below the dorsal region being made in this articulation and in the one just above it. In forward bending, the motion of the lumbo-sacral joint is made chiefly by the articular process of the 5th lumbar vertebra sliding upward upon the opposing processes on the sacrum,—habits in which the back is flattened must result in making the long axis of the sacrum more nearly vertical, and consequently the lumbo-sacral articulation more nearly horizontal. In this position the inter-spinous ligament in the lumbo-sacral portion of the spine must be stretched. With this, naturally, the motion at that joint will be more free and the articular process must be drawn more or less apart." (Goldthwait)

Secondarily, the stability of this joint depends upon the two articular processes, and mainly upon ligamentous support. The principal ligaments being, first, the lumbo-sacral ligament, arising from the

lower front part of the 5th transverse process, and being attached below to the lateral surface of the base of the sacrum; second, the ilio-lumbar ligament arising from the tip of the 5th transverse process and attached to the crest of the ilium. This condition exists on both sides of the lumbo-sacral joint, requiring four major ligaments and several minor ligaments to support this joint.

It must be further remembered that the lumbo-sacral cord,—which is made up from the roots of the 4th and 5th lumbar plexus, supplying the sensation to the buttocks, anterior and posterior aspects of the thigh and the sciatic region,— passes just under the transverse process of the 5th lumbar vertebra, and in intimate contact with the lumbo-sacral and ilio-lumbar ligaments.

Many anatomists tell us, and the x-ray of many lumbo-sacral joints show that the 5th lumbar vertebra varies in its articular processes and in the size and shape of its transverse processes. The variability of the articular processes would indicate a greater weakness of the lumbo-sacral joint, while the size and shape of the transverse processes do not influence greatly the ligamentous attachments. Many flat x-ray plates indicate an impingement of the transverse processes on the sacrum or ilium, but only stereoscopic plates can prove the true conditions.

Therefore, the foregoing brief anatomical description plainly indicates that the lumbo-sacral joint is distinctly a pivotal joint, upon which devolves all the motion of the trunk on the pelvis, the pivotal motion at this joint being produced by muscle contraction and expansion, but being controlled and limited by the ligamentous guy ropes which are short, powerful, and firmly attached. When in the erect position, the poise or posture of the body is maintained largely by the muscles, assisted at the lumbo-sacral joint by the two articular processes against the sacrum, the ligaments in this position being largely free from their duties of stabilization. However, in the position of forward bending, the lumbar spine is flattened, which renders the lumbo-sacral articulation (horizontal in the standing position) vertical, and calls upon the ligaments for the stability of the lumbo-sacral joint, assisted by the flattened, stretched muscles in and around the lumbar spine. While the trunk, in this position of forward bending at approximately a right angle to the sacrum, is a heavy load to hold, yet these lumbo-sacral ligaments are designed to maintain stability so long as the muscles assist and extra weight is not added; but should the muscles give away but for a second, the entire burden falls upon these lumbo-sacral ligaments. If, as in the momentary relaxation of

the posterior muscles of the spine, preparatory to lifting or pulling, this problem of stability devolves entirely upon the lumbo-sacral ligaments, with the added weight, the result invariably is a sprained or strained ligament. The sprain, in my opinion, does not differ from the ordinary sprained ankle (lat. lig.) or knee. The same type of structure (non-elastic ligament) is involved, the onset is sudden (a slipping sensation), the pain quite intense, and rapid swelling ensues. This swelling of the lumbo-sacral and ilio-lumbar ligaments is often sufficient to produce pressure and edema of the lumbo-sacral cord, which passes just under these structures, and in consequence, pain over the distribution of a part of the sacral plexus and the sciatic nerve takes place. The spinal and lateral spinal muscles are thrown into spasm in an effort to fix the lumbo-sacral joint and the adjoining painful area, the rigid spine, therefore, indicating that the lumbar spine or some adjacent part has been injured. It should also be borne in mind that such a strain untreated, or improperly treated, will become chronic and consequently of much longer duration than the acute condition, and more difficult to relieve.

Bony anomalies in relation to the lumbo-sacral joint are of, in my opinion, secondary importance. The stability of the joint is entirely dependent upon the normal anatomic structure. If an enlarged or elongated transverse process of the 5th lumbar exists, it would not influence the sprain above described, unless it were unusually long and a fracture produced. If a false joint between the ilium or sacrum, and a transverse process existed or if a bony union between these structures occurred, such would not prevent the sprain of the lumbo-sacral ligaments but, on the contrary, would add seriousness to the situation and intensify the sprain and the consequent inflammatory reaction.

If careful search is made when examining our cases it is rarely that we find a patient who has no active intercurrent infection. The focus may be the nose, the throat, or the teeth; or, further, a focus may exist in the abdomen or the genito-urinary tract. This last named source of infection may be the remains of a Neisser infection or the point at which the spirocheta palida has gained entrance into the blood stream. It is a well-established fact that if an intercurrent infection exists and an injury to any bone, joint or ligament occurs, that the lowered resistance of that part permits the infection or its toxins to attack that part and there form a more decided pathological lesion. In many instances if the infectious foci are cleared up the traumatized

part, whether by injury or operation, more promptly responds to recognized methods of treatment, or is capable of effecting its own cure.

Nothing has been so clearly demonstrated during the recent war, to those uninitiated in orthopaedic surgery, as the prime necessity for the fixation of traumatized parts, whether open or closed. If the wound is open, fixation reduces the pain and shock and retards contamination and later infection. If the wound is closed, such as an injured joint, the fixation puts the traumatized soft parts and strained ligaments at immediate rest, which means, if not too prolonged, ultimate restoration to normal. Hence in the lumbo-sacral strains, in addition to clearing up existing foci of infection, we resort to the common orthopaedic practice of fixation to relieve the ligaments of strain and putting them at rest, depending upon the muscles for poise or balance. In such conditions transverse and vertical strapping with adhesive plaster, fixing the pelvis and lumbar spine as one unit, is usually sufficient to give prompt relief. It is necessary, however, to reapply this as it loosens. If complete fixation is required, the application of a plaster jacket is indicated.

In reviewing the forty cases reported in the attached table it is readily seen that lumbo-sacral pain is much more common in men than in women. (If the sacro-iliac joints were at fault pain should be more common in women, especially during the ages of child-bearing). The proportion is thirty-four men to six women. The vast majority of the men were laborers, the remainder being clerks or having similar occupations requiring bending forward and lifting. The women were largely of the negro race and engaged in the occupation of laundress or cook, either of which calls upon the lumbo-sacral joint for much strain.

The onset of the pain in twenty-two of the cases was sudden and occurred while stooping or lifting or immediately after executing such a movement, such occurrences pointing to the fact, emphasized in a foregoing paragraph, that in stooping or lifting a momentary relaxation of the muscles took place preparatory to lifting and all the strain was placed upon the lumbo-sacral ligaments, a real sprain of these ligaments taking place. In the remaining 18 cases the onset was insidious, this being due to the gradual progress of disease or infection and in some of the cases occurring after periods of heavy labor but not referred to by the patient when giving his history. It also happens that the patient is of inferior mentality and a clear history is difficult to obtain, it being found later that several such strains have occurred

during the so-called insidious onset that should be looked upon as lumbo-sacral in character.

Localization of the pain to me is very striking. Thirty-seven cases definitely designated the lumbo-sacral joint or the lumbo-sacral angles as the point of pain and in each instance tenderness existed at this point or points. Two designated the left hip and thigh and leg as the site of pain, which was probably referred pain due to pressure of the lumbo-sacral cord from swelling of the lumbo-sacral ligaments. One case referred his pain to the sacrum.

Examination revealed that spasm of the spinal muscles existed in some decided form, varying from slight restriction of the spinal motions to complete rigidity, including also so-called "sciatic-scoliosis," in thirty cases. The spinal motions were free and painless in nine cases and in one case no record was made.

Inspection of the teeth showed that infective foci existed in the form of necrotic teeth, crowns and fillings (potential infectious foci) in eighteen cases. Three presented teeth poorly kept; one had no teeth; three mouths were negative, and fifteen cases showed no record of an examination of the teeth having been made.

Further inspection of the respiratory tract revealed that five cases showed infected tonsils or nose; seventeen were negative for pathology and eighteen showed no record had been made of an examination of the nose and throat.

It was interesting to note that the examiners felt that the glandular system was of little significance, for of the forty cases, thirty were not examined for glandular involvement; four cases showed epitrochlear enlargement (one of these having cervical enlargement); in five cases the glands were not palpable and the glands of one case were reported as not enlarged.

The radiographic study of these cases was exceedingly interesting and instructive. If my interpretation of these cases is correct, one would not expect the films to show bone lesions which would influence largely these lumbo-sacral strains. The analysis shows that the fifth lumbar transverse process was enlarged or elongated in twelve instances, and, in my opinion, does not represent a pathological lesion. (Of these enlarged transverse processes four cases also showed hypertrophic arthritis). Ten cases showed no record of an x-ray having been made. Nine cases were reported negative for any bone change. Four films were interpreted as sacro-iliac separation, which appeals to me as incorrect, in that we have no standard by which we can judge

such a condition except in extremes with commensurate symptoms, and in addition no symptoms were referable to the sacro-iliac joint. Five cases showed an hypertrophic arthritis of the hip joint, acetabulum and spine.

A record of the venereal infections shows us that three cases admit the occurrence of a chancre alone; four cases a chancre and Neisserian infection. Seven acknowledge Neisserian infection alone and one of these states his wife has had six miscarriages. Twenty-two cases bear no record of the venereal history having been inquired into, two giving negative history.

Wassermann examination of the blood reveals the fact that eighteen gave negative reactions, ten positive reactions, ten were unrecorded and two were anti-complementary. No additional laboratory tests were done to determine the presence of lues.

As soon as radiographic examination and laboratory tests have been made it has been customary in this clinic to bring about a moderate degree of fixation of the lumbo-sacral joint by means of adhesive plaster strapping across the posterior aspect of the pelvis and obliquely up and down the spine, thus joining as one unit the pelvis and the lumbar spine. As a rule when disease processes are found such as lues, necrotic teeth, etc., no strapping is applied unless no relief is obtained after removal of the infective process. Later, when this temporary fixation of the spine has served its purpose, a permanent support is supplied in the form of a well-fitting corset in the case of women and a wide webbing belt in the case of men. In those very stubborn cases a plaster-of-Paris jacket is resorted to. Of the forty cases reported, twenty-four received adhesive plaster strapping; three were corseted immediately; one was put in a plaster jacket and twelve received no fixation.

The treatment given these cases consisted mainly in clearing up infectious foci, administering mixed treatment for those having a positive Wassermann or who were otherwise suspected of having lues, and in giving occasional doses of aspirin and atophan. In many cases no other treatment was required than fixation of the spine. In this series of cases nine belts were given; one corset; nine had necrotic teeth removed; fourteen received mixed treatment, or salvarsan, or both; one had the tonsils removed; one the nose operated upon, and two received aspirin and atophan. In some instances one patient received more than one of the enumerated therapeutic aids.

The results of the treatment were indicative of the proper diagnosis

Sex	Onset	Location of Pain	Spinal Motion	Teeth	E. N. & Throat
M	Sudden onset while lifting	Lumbo-sacral region	Slightly limited—spasm of back muscles	Pyorrhea	Tonsils infected
F	Sudden onset while stooping	Lumbo-sacral region	Muscle restricted	Crown and fillings	Tonsils infected
M	Sudden onset while stooping	Lumbo-sacral region	Very much restricted	Poorly kept	Negative
F	Sudden onset while stooping	Lumbo-sacral and right loin	Not recorded	Necrotic roots	Nasal discharge
M	Sudden onset while stooping	Lumbo-sacral region	Free and painless	Not recorded	Not recorded
F	Insidious for two years	Lumbo-sacral region	Free and painless	Necrotic roots	Negative
M	Sudden—fall in pit	Left hip, thigh and calf	Very limited muscle spasm	Necrotic roots	Negative
M	Insidious for several years	Lumbo-sacral, left thigh and leg	Very rigid spine	No record	No record
M	Insidious for years	Lumbo-sacral region	List to the left and marked limitation. (Sciatic scoliosis)	No record	No record
M	Insidious for years	Left 5th trans. process and loin	Very much limited	Very necrotic	Negative
M	Sudden—stooping	Lumbo-sacral region	Entirely rigid	None	Negative
M	Sudden—stooping	Lumbo-sacral region	Sciatic scoliosis—rigid	Negative	Negative
M	Sudden—not stooping	Lumbo-sacral region, rt. iliac crest and right abdomen	Marked limitation	Necrotic	No record
F	Insidious for 2 months	Lumbo-sacral region	Free and painless	No record	No record
M	Sudden—after stooping	Lumbo-sacral and rt. lower abdomen	Moderately restricted	No record	No record
M	Sudden—while lifting	Lumbo-sacral	Moderately restricted	Necrotic roots	Negative
F	Insidious—3 years	Sacral	Free—pain on pressure—sacro-iliac	No record	No record
M	Sudden—heavy lifting	Rt. lumbo-sacral angle	Muscle spasm—lumbar	Necrotic	Negative
M	Insidious—3 years	Lumbo-sacral	Moderately restricted	No record	No record
M	Sudden—while lifting	Left lumbo-sacral angle	Very rigid with muscle spasm—"Sciatic scoliosis"	Very necrotic	Negative
M	Insidious for 10 years	Lumbo-sacral region	Free and painless—bad posture	Necrotic	Lues of nose (?)

F	Insidious for 10 years	Lumbo-sacral region	Very rigid	No record	No record
M	Sudden—while lifting	Lumbo-sacral region	Free and painless	No record	No record
M	Sudden—while lifting	Lumbo-sacral and left loin	Moderately limited and painful	Very necrotic	Negative
M	Sudden—while lifting	Both loins	Free and painless	Very necrotic	Negative
M	Sudden—fall 6 years ago	Lumbo-sacral region	Rigid and painful	Very necrotic	Negative
M	Sudden—while lifting	Lumbo-sacral region	Very rigid and painful—"Sciatic scoliosis"	Very necrotic	Negative
M	Sudden—while twisting	Lumbo-sacral region	Free and painless	Very necrotic	No record
M	Insidious—at night	Lumbar and dorsal region	Slight restriction	No record	No record
M	Insidious—10 years	Lumbo-sacral and abdomen	Very rigid—"Sciatic scoliosis"	Very necrotic	No record
M	Insidious—2 weeks	Lumbo-sacral	Marked restriction	No record	No record
M	Sudden—while lifting	Left hip and leg	Very rigid—muscle spasm	No record	No record
M	Insidious—5 months	Rt. lumbo-sacral angle	Very rigid	No record	No record
M	Insidious—3 years	Lumbo-sacral and both hips	Free and painless	No record	No record
M	Insidious—2 months	Lumbo-sacral	Moderate restriction—"Sciatic scoliosis"	Negative	Infected
M	Insidious since Influenza	Lumbo-sacral	Very much restricted	Poorly kept	Negative
M	Insidious—3 years	Rt. lumbo-sacral angle, rt. hip and thigh	Very rigid—"Sciatic scoliosis"	Very necrotic	Negative
M	Sudden—heavy work	Lumbo-sacral, left thigh and leg	Moderately restricted	Negative	Negative
M	Insidious—14 years	Lumbo-sacral	Moderately restricted	Poorly kept	Negative
M	Sudden—fall	Lumbo-sacral		No record	No record

Glands	*X-Ray*	*Venereal Hist.*	*Blood Wasser.*	*Fixation*	*Medication and Treatment*	*Result*
Not recorded	5th lu. transverse pro. impinges	Chancre	Neg.	Trans-adhesive strapping	None—belt	Complete relief
Epitroch. marked enlarg.	None	1 miscg.	Positive	Corset of good type	Mixed treatment	Complete relief
Not palpable	Enlarged 5th lum. tran. pro.	No record	Positive	None	Mixed treatment	Complete relief
Not recorded	Neg. for bone change	No record	Positive	None	Mixed treat.—606	Complete relief
Not recorded	Enlarged 5th lum. tran. pro.	Not recorded	Positive	None	Mixed treatment	Complete relief
Not enlarged	Sacro-iliac separation	No record	Positive	None	Mixed treatment	Complete relief
Not recorded	Overgrowth left acetabulum	No record	Positive	None	Removal of necrotic teeth—mixed tr.	Complete relief
No record	Hypertrophic arth.	No record	No record	Adhesive plaster	None	Complete relief
No record	Hypertrophic arth.	No record	No record	Adhesive plaster	Belt	Complete relief
No record	None	No record	Negative	Adhesive plaster	Removal of necrotic teeth	Complete relief
Epitroch. enlarg.	None	No record	None	Adhesive strapping	Mixed treatment	Complete relief
No record	Neg. for bone change	Chancre	Positive	None	Mixed treat.—606.	Complete relief
Epitroch. palpable	Hypertrophic arth. large 5th lum. tran. pro.	No record	Anti-comp.	Adhesive plaster	Removal of necrotic teeth	No return. Considered relieved
No record	Neg. for bone change	No record	Positive	Corset at intervals	Mixed treatment	Complete relief
No record	Hypertrophic arth. 5th lum. tran. pro. enl.	Negative	None	Adhesive plaster	None	Complete relief
No record	Neg. for bone change	Neisser inf—no sore	Positive	None	Mixed treatment	Complete relief
No record	Neg. for bone change	No record	Negative	Corset	None	No further complaint
No record	No record	No record	Negative	None	Removal of necrotic teeth	Complete relief
No record	Large 5th lum. trans. pro. Sacro-iliac sepa.	Neisser—no sore	Negative	Adhesive strapping —belt (webbing)	None	Complete relief
No record	Neg. for bone change	Neisser—sore	Anti-comp.	Adhesive plaster	None	Last report—improved
Not recorded	Hypertrophic arth. hip, spine	No record	Negative	Adhesive plaster—corset	Op. nose, teeth removed	Marked relief

No record	Sacro-iliac separation	No record	No record	Adhesive plaster	Corset—webbing straps	No further pain
No record	No record	Neisser—chancre	No record	None	Acute sprain	No further pain
No record	No record	No record	Negative	Adhesive plaster	Removal of necrotic teeth	No further pain
No record	Impinging 5th trans. pro.	Neisser	Negative	None	Webbing belt	No further pain
Not palpable	Neg. for bone change	Neisser	Negative	Adhesive plaster	Removal of necrotic teeth	No further pain
Not palpable	Negative	Neisser	Negative	Adhesive plaster	Webbing belt	Some pain continues
No record	Hypertrophic arth. enl. 5th tran. pro.	No record	Positive	None	Removal of necrotic teeth	No further report
No record	No record	No record	No record	None	Mixed treatment	No further pain
Not palpable	No record	Neisser	No record	Adhesive plaster	Removal of necrotic teeth	No further pain
No record	No record	No record	No record	Adhesive plaster	Webbing belt	No further pain
No record	Hyper. arth. Sacro-il. sepa. Large 5th tran. pro.	Neisser—sore	Negative	Adhesive plaster	Webbing belt	Marked relief
No record	No record	No record	Negative	Adhesive plaster	Mixed treatment	No further pain
No record	Marked hypertrophic arthritis	Neisser—sore	Negative	Adhesive plaster	Aspirin, belt	No further pain
No record	Sacro-iliac separation	Neisser—wife 6 miscgs.	Negative	Adhesive plaster	Tonsils removed	No further pain
Cerv. and epitroch. palpable	Enlarged 5th lum. tran. pro.	No record	No record	Adhesive plaster	Mixed treatment	Marked relief
No record	Enlarged 5th tran. pro.	Sore	Negative	Adhesive plaster	Atophan—necrotic roots removed	Some improvement
No record	Enlarged 5th tran. pro.	Negative	Negative	Adhesive plaster	Atophan—webbing belt	Marked relief
Not palpable	Marked hypertrophic arthritis	No record	Negative	Plaster jacket	Mixed treatment	Slight relief
No record	Negative				Jacket for 60 days	Little relief

of lumbo-sacral strain, without bone changes involved in the pathology, as the relief was prompt, and as far as I can ascertain, was lasting. The duration of treatment averaged about three weeks. Had a bony structure been involved, or a large joint been sprained, the relief could not have been so prompt, nor could it have been effected in such a short time. The record of these forty cases shows that twenty-eight reported complete relief; six were markedly improved; four received only slight relief, and two failed to report their condition.

CONCLUSIONS.

1. That the major portion of the cases of low back pain seen in the Orthopedic Clinic of the Touro Infirmary are believed to be sprains of the lumbo-sacral ligaments, with many superimposed intercurrent infections, including lues.
2. That the location of pain is definitely assigned by the sufferers to the lumbo-sacral joint or the lumbo-sacral angles, and not in the neighborhood of the sacro-iliac joint.
3. That no examiner does his full duty to his patient nor can he arrive at an accurate diagnosis unless a careful and complete examination is done (possibly excluding the heart and lungs), especially in reference to infectious foci. And further, that he insist upon these foci being cleared up.
4. That too much dependence is put upon the x-ray as an aid to diagnosis. It is most useful in determining fractures and real dislocations in and around the low spine, but that bony anomalies and so-called sacro-iliac separation shown should not be interpreted as the cause for the low back pain, especially in cases of sudden onset.
5. That a venereal history and investigation are of great importance in both sexes.
6. That adhesive plaster strapping when applied promptly and firmly to the entire spine gives early relief, but should be supplemented with some form of permanent fixation for a short period after the temporary fixation has been removed.

SUBSTITUTING FELT FOR STEEL ARCH SUPPORTS.

BY WALTER G. ELMER, M.D., PHILADELPHIA.

A FEW years ago we were so accustomed to use steel arch supports to relieve foot strain that it seemed most unlikely that we would ever be induced to give them up altogether. But we have such a good substitute which has certain advantages over steel, that I find I have gotten away from the use of steel and am using felt altogether. It is more comfortable for the patient and is much easier to handle.

At one time I made a plaster-of-Paris model of the patient's foot—the foot being held by the patient as much in supination as possible, and the plaster model was sent to the instrument-maker, and by the aid of this he fashioned the steel arch. The method was satisfactory, as a rule, although it usually required some time for the patient to become accustomed to the rigid support upon which he was walking.

Gradually, we have gotten more and more accustomed to using felt. The foot soon adapts itself to the pad and, if necessary, the shape and position of the pad can be easily changed to meet the conditions. Piano felt is used. It is compact and firm and does not lose its shape, and it does not, as a rule, flatten down under prolonged use. Perhaps it would be worth while to outline briefly the method which I usually follow in the examination and treatment of the patients that come to my out-patient clinic complaining of various foot conditions, and indicate the extent to which felt is used in affording relief to the patient.

A typical case is that of a young woman who is earning her living and is obliged to be on her feet all day. She complains of pain in one or both feet. Probably it has been several weeks or months since she first began to suffer. The aching pain increases during the latter part of the day, and she returns home from her work tired out—anxious to get off her shoes and to get to bed early. When she first gets up in the morning her feet are stiff and painful. She is lame in walking about her room, but after moving about a little the pain and stiffness grow less and may disappear altogether, but later in the day the sense of fatigue comes on, then the dull, aching pain returns and grows worse towards night. She has probably been treated for rheumatism, but the symptoms continue and gradually grow worse until she may be obliged to give up her work.

Examination of the patient usually shows that she turns her feet far out in walking. The line of weight-bearing falls to the inner side of the foot, causing an overhanging inner malleolus; the inner border of the foot is slightly convex; the anterior portion of the foot may be moderately abducted upon the posterior portion; there probably is a fair longitudinal arch, although it is probably lower than it should be, and there may or may not be a hallux valgus. The position is one which is characteristic of foot strain or a weak foot. There is apt to be tenderness along the under and inner aspect of the scaphoid bone, also under the external malleolus, and the heads of one or more of the metatarsal bones may be tender. Uusually there is very fair mobility of the foot, although dorsal flexion is apt to be limited. The tendons of the peroneus longus and brevis muscles may be unduly tense, due to spasm or contracture in these muscles, and this may prevent the foot from being brought into correct position under the leg for weight-bearing. There are also cases where the calf muscles are contracted, preventing the foot from being brought easily to a right angle and into the correct line under the leg. The patient usually complains of pain through the instep, and it radiates up the leg to the knee. Sometimes it starts in the ball of the foot, and is sharp and lancinating—characteristic of metatarsalgia. There may be painful calluses under the ball of the foot, under the ball of the little toe, under the great toe, and also troublesome corns.

If we examine the shoe we find it is much narrower than the foot, pointed toe and high French heel. A correct shoe is the first requisite. I have the patient stand upon a piece of paper and make an outline tracing of the foot and on this diagram draw a line across the ball and write upon it the width in inches. The patient is instructed to purchase a shoe which is not more than 1/4 of an inch narrower than her foot. The shoe should be about one inch longer than her foot and have a medium rounded toe. The inner border of the shoe should be straight, permitting the great toe to lie in a straight line with the first metatarsal bone. There should be a square or a Thomas heel about 1 1/4 inches high and the shoes should have rigid shanks built into them.

The weight is transferred to the outer side of the foot, and the correct line of weight-bearing restored by the sloping sole and heel, the lift of leather being one-eighth inch or three-sixteenths of an inch along the inner margin. The hollow of the foot is supported by a felt pad which rises up along the inner side and slopes off to a thin edge at its outer side.

In cases of metatarsalgia, which is often associated with weak-foot and flat-foot, the pad is extended forward to support the metatarsal arch as well as the longitudinal arch. The ball of the great toe rests upon the sole of the shoe, as does that of the little toe also, but the felt, as it crosses the shoe just back of the ball of the foot, is raised in the centre to support the neck of the second, third, and fourth metatarsal bones. This maintains the bones in their normal relationship, relieves the heads from pressure and prevents the pinching of a nerve between them. It seems to me that our results are better when we use the sloping sole and heel, forcing the patient to bear his weight more on the outer side of his foot throughout its entire length, than when we use the sloping heel only. The wedge in the heel, however, may be a little greater than that in the sole. The fact that the width of the heel is less than the width of the sole means that the heel is given a more decided slope than the sole if we use a wedge of the same thickness in both. In adults three-sixteenths of an inch is the routine thickness. Sometimes only one-eighth inch is used, and occasionally one-fourth inch. Very rarely is as much of a tilt as one-third inch required.

I usually order a man's shoe the same width as his foot and about one inch longer than his foot. Men do not object to a shoe of the proper size and shape. But women, as a rule, do. It is surprising the extent to which women will go, and the amount of suffering they will put up with in order to wear what they consider good-looking and fashionable shoes. This is partly the fault of the woman herself and partly the shoe-dealers. The object of the latter seems to be to please and flatter their customers, and many of the dealers tell their customers that the shoe must be tight enough to support the foot. Here is a case in point. A woman came into my dispensary because she suffered from her feet. She limped painfully when she attempted to walk and could walk only a short distance. She had taken her troubles to one of our large department stores and finally found herself in charge of the woman who was at the head of the shoe department. This woman had discovered that her customer was suffering from "fallen arches and what she needed was a shoe that would support the foot." So the patient was provided with a pair of low shoes, French heels two and three-fourths inches high, sharp pointed toes. I made an outline tracing of this patient's foot while she was standing. It measured four and one-fourth inches across the ball. The sole of the shoe was two and seven-eighth inches at its widest part. The length of the shoe was less than the length of the foot. This was the shoe that was intended to support

the arch. When the patient was provided with the shoe which her foot required, sloping soles and heels and a felt pad under the hollow of the foot, she was able to walk as far as she liked in comfort.

The patients object at first to the size and shape of the shoes, but when they realize the comfort they obtain from them and the extent to which their symptoms rapidly disappear, they become reconciled to the change and are not anxious to return to the fashionable models. And where there were painful corns and calluses the results are equally satisfactory, as these entirely disappear in about three months and the skin of the foot becomes smooth and soft.

In those cases of flat-foot due to spasmodic contraction of the peroneus longus and brevis muscles, the correct position of the foot cannot be maintained until the cause is removed. A resection of one-half inch or three-fourths of an inch of the tendons of the peroneus longus and brevis muscles above the malleolus permits the foot to be brought easily into an overcorrected position and immobilized in plaster of Paris for four weeks. It can then be kept in the correct line by the special shoes with sloping sole and heel and a felt pad under the instep. It is sometimes necessary to lengthen the Achilles tendon, and I prefer to do this by a plastic operation rather than by a simple subcutaneous tenotomy.

In cases of rigid flat-foot it is necessary to restore the foot as nearly as possible to the normal contour by operation. It is usually necessary to divide the peroneus longus and brevis tendons. The foot is then forcibly corrected over the König block, the arch restored and the foot brought around into supination as much as possible and fixed in plaster of Paris from the toes to just below the knee. The patient is permitted to use crutches, his weight falling on the outer borders of his feet, and the casts are worn for six weeks. When they are removed the special shoes are put on. These have a lift of one-fourth of an inch along the inner margin and a felt pad under the instep. The patient should not be permitted to put his foot on the ground without this support unless he is voluntarily able to hold his feet in the corrected position and walk on the outer edges of them.

Patients suffering from painful and tender heels which are not due to spurs on the os calcis can often be very much relieved by making a hollow in the heel of the shoe and placing in this a soft cushion heel pad of rubber. A felt pad is placed under the hollow of the foot to receive the weight and relieve a considerable part of the weight-bearing from the heel.

This outline gives briefly the extent to which felt can be used instead of steel. The various foot conditions can be met in a satisfactory way without using any form of steel arch support, either for the longitudinal arch or the metatarsal arch, and it does not seem necessary to use the Thomas heel or the anterior heel. And it should be kept in mind that it is the shift back to the normal line of weight-bearing and the properly placed felt pad which relieves the foot from strain, and not forcing the foot into a shoe which is too small in order to gain support for the foot. The foot requires free play for the action of its muscles and should not be put into a shoe which restricts muscle action.

The family physician not infrequently refers his foot cases to an orthopædic instrument-maker and expects him to make the diagnosis and carry out the treatment. This, naturally, results in many mistakes. A rather striking example of this is the following:

A woman had been referred by her doctor to a firm in New York whose specialty was to make shoes to order for persons who had pain in their feet. Plaster-of-Paris models were made of the patient's feet and from these a pair of shoes was made. No instructions had been sent by the doctor. The price of the shoes was $136.00. The patient still had pain, and believing the shoes were not right, ordered a second pair. As it was not necessary to make the plaster casts over again, these shoes were $36.00. The result was no better and the patient told me that she had nine pairs of shoes made. Each pair was $36.00 except the last ones, which she had on when she came to my office, and those were $40.00. The case was a typical one of painful metatarsalgia. No diagnosis had been made of the condition and consequently no effort had been made to correct it. The shoes were far too narrow. I ordered a ready-made shoe of the proper size and shape, sloping soles and heels, rigid shanks and felt pads to support the hollow of the foot and extended forward to support the metatarsal arch also. The patient had immediate and complete relief from her symptoms and could walk in comfort. According to her statement she had paid $428.00 for shoes which had to be discarded.

Patients are always taught to walk with their feet parallel.

News Notes

Clinical Orthopedic Society.

The Central States Orthopedic Club, which has been very successful in arousing interest in orthopædic surgery throughout the Middle West, has reorganized under the name of the Clinical Orthopedic Society, a step in large measure due to the efforts of the retiring president, Dr. M. S. Henderson.

From its conception nine years ago, the Club has been entirely clinical, no papers being presented, and as the organization has long since passed the club stage, the new name has been taken as more indicative of the aims and aspirations of the Society.

The last meeting, according to the custom of visiting two centers a night's ride or less apart, was held in Iowa City, November 11, 1921, and in Kansas City, November 12, 1921. Dr. F. C. Kidner, of Detroit, has been elected President for the coming year, and the next meeting will be held in the Twin Cities and in Rochester, probably in October.

We Take from the "Gazzetta Ufficiale" of the 20th of January, 1922, No. 16, Istituto Ortopedico Rizzoli-Bologna, the Following Announcement:

Referring to article 15 of the statute for the Umberto I Prize, for which the competition opened on the 1st of January, 1920, and closed on the 31st of December of the same year, we publish the award for the assignment of the prize submitted by the Commission, composed of the Prof. Sen. F. Novaro, R. Dalla Vedova and V. Putti.

The Commissaires have agreed and concluded "that the prize must be assigned by merit to Dr. Murk Jansen, of Leyden, for the work presented for the competition.

Il Commissario Prefettizio,

Bologna, 24 January, 1922. G. Bellini.

At the invitation of St. John's University, Shanghai, The Shantung Christian University Hospital, Tsinan, and the Pekin Union Medical College, Dr. E. G. Brackett of Boston has recently gone to China for three months to conduct a course of instruction to further the development of orthopædic surgery in the Orient. The hospitals have arranged to turn over to Dr. Brackett the facilities of their wards, so that in addition to didactic lectures, there will be practical bedside instruction and operative work in orthopædic conditions.

Current Orthopaedic Literature

TUBERCULOSIS.

Extra-Articular Tuberculosis of the Patella. G. Jean. *Revue d'Orthopédie*, September, 1921, p. 393.

Two cases are reported.

1. Man of 44. Injury to right patella by direct violence in July, 1917, followed by rather sharp pain which persisted for several days. January, 1918, same pain recurred and was accompanied by swelling. A month later a definite tumefaction appeared, without fever. This was incised and some bloody pus evacuated. Fistulas persisted at each incision on either side of the patella. In July, 1919, the roentgenogram showing a point of rarefaction in the patella and the Wasserman being negative, two fairly long incisions were made on either side and a cavity on the posterior surface curetted out. Under heliotherapy without immobilization the wounds were healed and the patient was well by October, 1919.

2. Man of 21. Pain over the left patella appeared spontaneously. A tumefaction occurred and was treated in the same manner as the preceding case. Three months after operation the patient had entirely recovered under heliotherapy without immobilization.

There was little or no functional disturbance of the knee in either of these cases.

There are about a hundred cases of primary tuberculosis of the patella found in the literature since 1888. Due to change in structure of the patella with age, the lesion occurs in the anterior part in children and the posterior part in adults. The joint is not involved because the point of the patella where the lesion occurs is in relation to the fat pad and is thus extra-articular. This localization of the disease is regarded by Mayet as analogous to tubercular epiphysitis. It is thought that exposure of this part of the patella to trauma predisposes to the lesion. Surgical intervention is the treatment of choice, and cure is relatively rapid. The rarefied portion of the bone should be thoroughly removed, care being taken not to go through into the synovial membrane.—*William Arthur Clark, Pasadena, Calif.*

A Variety of Tuberculous Coxalgia in the Adult: Dry Caries of the Hip. Maurice Patel. *Revue d'Orthopédie*, September, 1921, p. 385.

For a long time (since Wolkmann) a special form of tubercular osteoarthritis has been recognized under the name of dry caries. It has been described in the shoulder, hip, wrist, and elbow. Rottenstein and Houzel (1910), in reporting two such cases of the hip, stated that they found, among lesions going under the names of osteoarthritis deformans juvenilis and monarticular tubercular rheumatism, a certain number of cases which they con-

sidered as dry caries. It is characterized by an eburnation of the femoral head without fungosity or joint effusion.

The author reports a case of a woman of 52 who began to have rather violent pain in the right hip, which after a month confined her to bed, unable to walk. She has been losing strength for a year. The hip was in abduction and external rotation and the pelvis was tilted toward the affected side. All movements limited and painful. Muscular atrophy of 3 cm. A diagnosis of tubercular hip was made at this time. After immobilization of fifteen months the patient walked with a cane, although motion was not normal and was still somewhat painful. The symptoms gradually subsided during the following year, but then she suddenly noticed a lack of support and the right hip seemed to dislocate at every step. Examination then revealed, practically, a flail hip with 3 cm. shortening. When weight was borne on the right leg the great trochanter went up into the iliac fossa. The roentgenogram four months later showed that the head and neck of the femur had disappeared and that the great trochanter was rarefied. The acetabulum was equally rarefied, but its depth and form were preserved. The patient refused operation and continued to walk with a brace and pelvic belt.

This case seems to have progressed in two periods: (1) a period of arthritis with pain, muscular atrophy, and impairment of function. (2) a period of bone destruction which began about the time the patient began to walk. The woman was known to be tubercular and there was no doubt that the hip lesion was due to this disease, although there was no joint effusion.—*William Arthur Clark, Pasadena, Calif.*

TRAUMATA.

OLD OS CALCIS FRACTURES. Fred J. Cotton, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This article by Dr. Cotton is well worth consideration, as it deals with a condition that is of great importance, especially in industrial surgery. The author's suggestions are the result of much thought with reference to these old cases of continued disability following injury to the ankles. In early cases of ankle injury with fracture of the os calcis the author's well known method of remodeling is strongly advocated, even in the presence of impaction.

This article, however, deals with the old cases which have had a long period of disability, which have not responded to the various lines of procedure that are usually employed.

The pathology is evidenced by a thickening of the heel on the outer side, caused by impaction or callus production, the callus sometimes being so extensive that it impinges upon or surrounds the malleolus. This bony contact is the cause of the discomfort.

X-ray reveals this deformity when the exposure is made from behind and above, diagonally downward and forward through the heel, revealing the contour of the os calcis.

Dr. Cotton advocates evulsion of the excess of bone, clearing the inter-

ference with the outer ankle after the following manner: "Incision is made downward and forward beneath the external malleolus; stripping up and laying forward and upward of a flap, including the peroneal tendons in their sheath, turning up with them the periosteum and with it the cortical layer of the bone; then comes a thorough clearing away of all of the excess of bone, deep below the cortical level, leaving a saucer-like crater of bone. In doing this clearing away one cuts across the posterior astragalo-calcaneal joint regardless of the ligaments and capsule. Then, forced manipulation in rotation and in abduction and adduction of the foot complete the clearing of any obstacle to motion from the bone, from adhesions or from scar. At this stage, after reduction, motion should be near normal and unimpeded by adhesions or excess of bone. After clearing away the excess of bone the periosteal flap, carrying tendons, is laid down into the crater from which the excess bone has been removed. Loose suturing completes the operation. Plaster is applied in neutral position. Pressure is applied from outside to press the flap into position. After two weeks the bandage is removed and passive motion is begun. Weight bearing is allowed after six weeks, using caution. In some cases a Whitman support is used temporarily. The case should be kept under observation until maximum improvement is obtained."

The article is accompanied by a series of case reports that are indeed encouraging.—*A. G. Nichol, Nashville, Tenn.*

FRACTURE OF THE SCAPHOID OF THE FOOT. A. Rosenberg. *Deutsch. Zeitschrift f. Chir.*, 1921, Vol. 164, p. 394.

An extensive review of the heretofore reported cases of such fractures is outlined and the history and management of one of the author's own cases is added.

The mode of production of the scaphoid fractures is considered as follows: The individual falls from a height and lands on the feet; to minimize the force of impact, the feet are plantar flexed, endeavoring to alight on the toes; losing equilibrium, the person falls backward. During this backward fall, the scaphoid becomes compressed between the cuneiform anteriorly and the astragalus posteriorly, and breaks.

The author advocates the abolishment of operative treatment, such as nailing or extirpation, but bandages the foot in a corrected position of supination, and encourages standing and walking, notwithstanding the pain. Local heat and massage is applied to hasten recovery.—*A. Gottlieb, Los Angeles, Calif.*

FRACTURE OF THE NECK OF THE FEMUR. A report of Three Cases with Delayed but Successful Application of the Whitman Abduction Treatment. S. Kleinberg, *Medical Record*, January 7, 1922.

These cases are reported in detail and the results seem to justify the use of this method even several months after the original injury. Proper manipulation is believed by the author to be indispensable.—*Edward S. Hatch, New Orleans, La.*

CERTAIN PROBLEMS CONCERNING FRACTURES OF BONES. Charles M. Scudder, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This is a review of the general methods now used in the treatment of long bone fractures, bringing out nothing especially new in technic, but strongly advocating a better understanding of the subject and a more efficient training of the individual surgeon in this line of endeavor.

There is a demand, especially on the part of the workingman and his employer, for greater skill and a shorter period of disability, and in this article the author endeavors to outline a method by which this improvement may be attained. This method is by organizing special fracture service in each of the larger hospitals of the country after the following fashion.

"(A) Special wards should be used for men, women, and children, and only fracture cases admitted. It is impossible to care adequately for these cases when they are scattered throughout the hospital. Responsibility is divided among many individuals. No concentrated interest results. Too much work is delegated to ignorant subordinates. The general service would be more free if separated from the fracture cases.

(B) A special fracture personnel should be in charge of fracture wards. There should be a chief of this service, a surgeon of broad general experience, whose interest should be active in moulding the policy of the fracture division. He alone should be finally responsible for results. Serving under him should be the necessary assistants, etc. This service should be continuous throughout the year.

(C) This service should be in continuous control of the Out-Patient Service, where ambulatory cases are received and treated. Each day of the week there should be an Out-Patient clinic for fractures, which the fracture service controls and with which it is in intimate touch. The policies of the Out-Patient and House Fracture Services should be identical under the Chief of the service. Cases of fracture should be followed until maximum functional results are obtained and until the wage-earner is on his feet and re-established again.

(D) The emergency ward or accident service, in so far as fractures are concerned, should likewise be under the care of the Chief of the Fracture Service. A fracture received into the accident ward should be regarded as an emergency case requiring the immediate attention of those who are directly responsible for the ultimate result. A fracture should be considered as much an emergency as is a case of perforated gastric ulcer. The initial treatment is vital to a satisfactory outcome in both instances.

(E) An operating plant in connection with the House Service is essential. The operative fractures must be kept apart from septic operations. Separate instruments must be employed."

Together with these recommendations are suggested lecture rooms where the subject can be adequately taught in a graduate school and to undergraduates, though to these latter only after they are well grounded in the fundamentals, and this instruction should be given in the third and fourth years.

The institution of smaller units in outlying centers and the liberal use of educational propaganda.

Encouraging specialization within general surgery of the surgery of fractures.

The author feels that there is ample room for a specialty of fracture and traumatic surgery in the larger communities, and that there should be ample demand for such a specialty.

During the war the orthopædic surgeon did efficient work in fractures and traumatic surgery, and as the result there is a question that is being forced upon Staffs of Hospitals, "Shall fractures of bones and traumatic surgery be delegated to the members of the orthopædic staff of our hospitals?" There is opposition to this course, based largely upon the fact that many capable men who are doing efficient orthopædic surgery are not qualified as general surgeons, and for this reason it is believed that the general surgeon is more capable of caring for this type of work.

The author states that "The door to special surgical work should always be through general surgery" and believes that the time is coming when young men will specialize in traumatic surgery, and considers the present scope of orthopædic surgery is sufficiently large to occupy the orthopædic surgeon. —*A. G. Nichol, Nashville, Tenn.*

INFLUENCE OF PHYSICAL THERAPY IN REDUCING TIME OF DISABILITY IN FRACTURES OF THE LONG BONES. Jonathan M. Wainwright, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This is a short article advocating the early use of physical therapy in fractures of the long bones and accompanied by a table of comparative results, showing an improvement of from twelve to twenty-eight per cent., resulting from this adjunct to the usual methods of treating such fractures. There is no especial technic mentioned.—*A. G. Nichol, Nashville, Tenn.*

NOTE ON THE INJURIES TO THE SEMILUNAR CARTILAGE OF THE KNEE. With Special Reference to Industrial Accidents. James Eaves and Paul Campiche. *Medical Record*, December 24, 1921.

This paper takes up the subject as it interests surgeons having the care of industrial accidents, and stresses the two points: "When Should We Operate?" and "What Character of Operative Procedure Should be Followed?" The writers feel that many patients get well without operation, but as they often see patients after alleged "reduction" when the patients are still suffering, they feel that after a period of six weeks, operation by the method of Sir Robert Jones should be done. Excision should be as complete as possible. —*Edward S. Hatch, New Orleans, La.*

PARALYSIS.

TREATMENT OF NEGLECTED CASES OF CLUB-FOOT. A. Paynter Noall. *British Medical Journal,* December 31, 1921.

Under this title the author discusses paralytic equino-varus and calcaneo-valgus, also claw-foot. For the equino-varus he describes a technic of resection of the mid-tarsal joints with plantar fasciotomy and Achilles lengthening. If the tibialis anticus is acting strongly he also transfers its attachment to periosteum over the cuboid. The posterior ligament of the ankle joint is also divided. There is the usual after-treatment of plaster, varus brace and massage.

This same procedure is advised for the various types of claw-foot or pes cavus.

For calcaneo-cavus he employs the two-stage operation of Sir Robert Jones. Whitman's operation is not mentioned.

In extreme cases of paralysis he assumes that apparatus must be worn permanently after these operations.—*R. W. Billington, Nashville, Tenn.*

BIRTH PARALYSIS. H. Platt. *British Medical Journal,* November 26, 1921

The author believes that clinical, experimental and operative evidence are all in favor of the view that in most cases there is a supraclavicular lesion of the brachial plexus. In the majority of such cases the nerve lesion is of the incomplete anatomical type and is followed by unhindered spontaneous regeneration. A few cases may be due to injury to shoulder joint capsule and secondary involvement of certain branches of the brachial plexus.

Considerable spontaneous recovery usually occurs in a few weeks or months. Whether the nerve recovery be complete or incomplete there usually remains more or less contracture and subluxation of the shoulder joint which become more marked with time and growth, but which can be prevented by proper early treatment consisting of correct posture and physical therapy. He does not approve of operation on the plexus before nine months of age and not then unless there is still complete paralysis and marked atrophy indicating no recovery. He thinks it of doubtful value in any case.

Contractures and subluxations of the shoulder are corrected by stretching and continued posture of overcorrection, cases over two years old usually requiring open division of contracted tissues as done by Sever, of Boston. He thinks that in most untreated cases the deformity is not due to failure of nerve regeneration, but is mechanical or postural. In his thirty-four cases, the paralysis recovered in twenty-nine. In six old cases with residual paralysis in the lower arm four showed recovery after prolonged splinting in the relaxed posture. In the other two cases tendon transplantation was performed.—*R. W. Billington, Nashville, Tenn.*

NEOPLASMS.

ACTION OF RADIUM ON TUMORS OF THE BONE. With Report of Two Cases. Isaac Levin. *Medical Record*, Vol. 100, No. 10, October 15, 1921.

The author reports a case of carcinoma of the breast with metastasis in the humerus and pathological fracture. An x-ray showed complete destruction of the bone for over an inch. The fracture was treated with three packs of tubes of radium emanations, one pack on the anterior surface, the others on the external and internal surfaces of the arm. In all 208.9 millicuries of radium emanations were applied for sixteen hours. This treatment was repeated in a week, using 249.1 millicuries for the same time. Two weeks after the first application an x-ray showed callus and the patient was able to support her arm without splints.

In the second case the patient had a tumor in the region of the upper third of the tibia. The x-ray showed a defect in the bone about two inches long and one inch wide. On operation it was found that the tumor had invaded the muscles, and on removal only a small shell of the outer wall of the tibia remained. A brass box with radium emanation tubes was placed in the cavity giving 213.0 millicuries for sixteen hours. This was followed by several applications of radium packs over the operative field. Twelve months later an x-ray showed the cavity filled with compact bone. The nature of the tumor was not stated.

The author believes that radium causes a very rapid formation of new bone. It seems feasible to suppose that radium therapy may hasten callus formation in fracture and increase the success of bone implantations. Multiple myeloma of the bone is more akin to lympho-sarcoma than to true sarcoma or carcinoma and must therefore be more radio-sensitive than the latter conditions. Chronic inflammatory diseases of the skeleton, osteitis or osteomyelitis present frequently pathological pictures similar to sarcomata of the bone. It is possible that if these were treated as in case two, satisfactory clinical results might be obtained.—*A. O'Reilly, St. Louis, Mo.*

GANGLION OF THE WRIST REGION. WITH REPORT OF TWO CASES SHOWING DESTRUCTIVE TENDON INVOLVEMENT. H. P. H. Galloway. *Canadian Medical Association Journal*, October, 1921.

The two varieties of swelling in the wrist region to which the name "ganglion" is attached, are described and differentiated, the tuberculous nature of the compound diffuse ganglion being emphasized.

The treatment recommended for both conditions is extirpation by careful dissection. In the case of the tuberculous lesion this predicates a minute knowledge of the anatomy of the region, and patience to undertake a painstaking operation of possibly two hours in length. The advantages of a bloodless field are evident, and to diminish the chance of Esmarch paralysis, the use of two tourniquets of rubber tubing is recommended, one applied above the

elbow, the other below, each for approximately one-half of the time of operation.

While the tendons themselves usually escape destruction they are not infrequently involved in long-standing cases, and thorough removal of the disease necessitates the sacrifice of tendons where these are extensively involved. The recovery of function is usually surprisingly good. It is assisted by gentle passive movement from the third day onwards, and radiant heat, massage, and systematic exercises after healing is complete. Two cases are quoted. In both the long flexor tendon of the thumb was sacrificed and in one of these the tendons of the flexor sublimis also suffered. In both "the functional result was excellent."—*Alexander Gibson, Winnipeg, Manitoba.*

METABOLIC DISTURBANCES.

TREATMENT OF RAYNAUD'S DISEASE WITH THYROID EXTRACT. Edwin W. Hirsch. *Medical Record*, January 7, 1922.

A general outline of Raynaud's disease is given, in which history, pathology, symptoms, and diagnosis are taken up. One case is reported in which the use of thyroid extract gave marked relief.—*Edward S. Hatch, New Orleans, La.*

FRAGILITIS OSSIUM. Edgar A. Vander Veer, M.D., and Arthur M. Dickinson, M.D. *Annals of Surgery*, November, 1921.

"In all the case reports reviewed there was no reference to an abnormal condition of the teeth. Practically all referred to the teeth as negative or in good condition. In the case we are reporting, the child has a very interesting condition of the teeth. They are almost all translucent and show every evidence of lack of mineral salts. The mother informed one of us that the first teeth were the same and did not last any time at all, but were so fragile that they soon crumbled. The permanent teeth seemed much the same as the deciduous set in this regard."

Author reports a case in which a child had, in all, fourteen fractures. These were all located in the femur and mostly in the right one, a sudden turn or a sharp twist often being enough to cause a new one.

Conclusions:

1. Fragilitis ossium is a relatively rare condition and is accompanied by blue sclera.

2. The etiology is unknown in the large majority of cases, less than ten per cent. being on an hereditary basis.

3. There is no demonstrable relationship between fragilitis ossium and any other bone condition, as scurvy, tuberculosis, syphilis, osteomalacia, etc.

4. The treatment is very unsatisfactory and offers no hope of cure.—*Thomas Madden Foley, Washington, D.C.*

ETIOLOGY OF RICKETS. G. Bruton Sweet. *British Medical Journal,* December 24, 1921.

The various theories, old and new, of the causation of rickets are mentioned and his own observations of the disease in New Zealand, as compared with Great Britain, are interestingly discussed. His conclusions are: (1) That rickets is due to fat-soluble A vitamin has not been proven. (2) It is primarily due to a diet deficient in fresh animal food, probably suitable protein, or a disturbed digestive condition which prevents assimilation of same. (3) The striking metabolic changes are due secondarily to deficiency of secretion of one or more endocrine organs, probably chiefly of the thymus. (4) Confinement with attendant evils of lack of sunshine, exercise, and cleanliness are important factors in increasing the severity of the disease.—*R. W. Billington, Nashville, Tenn.*

OSTEOMYELITIS.

A CLINICAL STUDY OF THE PATHOLOGY OF OSTEOMYELITIS. A. Gibson. *Canadian Medical Association Journal,* November, 1921.

There are two distinct types of osteomyelitis, juvenile and adult; the first metaphyseal, the second may occur anywhere in the bone. Of forty-eight cases occurring in civil practice, the average age of onset was 17, the youngest 7½ months, the oldest 64 years. Of fifty-nine bones affected forty-four were in the lower limb.

In regard to etiology 24 cases showed no direct existing cause, while the remainder were the result of traceable local or systemic infection.

Ten cases showed recurrence in another bone of the body, after an interval generally reckoned in years. Five deaths are recorded in the series.

The different varieties of sequestra are considered, special note being made of the "lining" sequestrum, a thin tube of dead bone found in the shaft of long bones in three cases. Organisms may remain beleaguered in a bone abscess for an indefinite period, one case in the series showing an interval of thirty-eight years.

Summaries of the cases are given, and two cases are cited in detail to show the relentless manner in which a bone infection remains ready to break out. In the second of these cases, the first attack occurred in 1870 when the patient was 14 years of age. Attacks occurred at intervals, amputation being performed in 1908. Death occurred in 1920 from recrudescence in the stump.

HEMORRHAGIC OSTEOMYELITIS. Ernest H. Arnold. *Boston Medical and Surgical Journal,* December 8, 1921, p. 677.

Hemorrhagic osteomyelitis is apt to exist without symptoms, subjective or objective, and may go, therefore, unrecognized. If the lesion be situated near a joint, it may be mistaken for a joint lesion such as tuberculosis, or it

may be taken for a malignant bone tumor. Conservative treatment, as a brace, has no influence on hemorrhagic osteomyelitis. Radical interference is necessary.

Etiology. The lesion is not frequent, because it exists unrecognized and undiagnosed. Its preference for spongy bone explains its occurrence in childhood and youth. In the author's group of cases there was none older than twenty-five. History of trauma is frequently given.

Pathology. There is a cavity in the spongy part of a long bone, filled with a dark brownish mass of jelly-like material, into which uncoagulated blood oozes. A membrane, brownish red, lines the cavity. The cavity expands, driving the cortex before it. The microscopic picture is the following. The mass is found to be a hemorrhagic extravasation in which light-colored areas, consisting of young fibroblastic tissue, are noticed. In these are found many multinucleated giant cells of the foreign-body type of cell. This cyst formation and the presence of giant cells were undoubtedly responsible for the view held in many quarters, until quite recently, that the condition was one of tumor formation, bone cyst, of this being classed as giant-cell sarcoma. However, it is now recognized that the process is one of a low-grade inflammation, usually chronic in character, in response to trauma. The giant-cells have not a tumor-forming but a scavenger function.

Diagnostic Points. There are no general symptoms such as fever, anemia, or loss of weight. There may be no local symptoms. The lesion may be accidently discovered by x-ray or there may be a spontaneous fracture. Pain and the usual signs of inflammation may be late. There is no muscle spasm or atrophy. The process is of long duration and there are no exacerbations or metastases. Hemorrhagic osteomyelitis is to be differentiated from malignant bone tumor (sarcoma) and bone tuberculosis. These latter, however, are usually ruled out by x-ray.

Treatment. Curettage of hemorrhagic membrane and whole cavity and recesses; close without drainage. A protection splint is worn. X-ray pictures at frequent intervals control the recovery. The prognosis is good. The author discusses four cases, two in tibia, one in humerus, and one in femur. —*Voigt Mooney, Pittsburgh, Pa.*

MISCELLANEOUS.

Some Factors in Bone Repair. William Seaman Bainbridge. *Medical Record*, January 7, 1922.

This is a very interesting and timely paper in which the author points out at some length the causes other than local which interfere with the proper repair of fractured bones. He cites: (1) Blood; bacteriology, including lowered resistance of fractured bones; metastatic infection from concealed foci; constitutional diseases. (2) Blood chemistry. (3) Interference with the constructive metabolism of bone through injury to the nutrient artery.—*Edward S. Hatch, New Orleans, La.*

RHEUMATOID ARTHRITIS: LESSON OF TWENTY-FIVE YEARS' EXPERIENCE. N. Davies. *Practitioner*, December, 1921.

Results of observations and treatment of rheumatoid arthritis over a period of a quarter of a century at Llandrindal Wells and elsewhere.

If microbic theory were the originator of the mischief, treatment with autogenous vaccines would not be the failure it generally is. If good results followed the wholesale extraction of teeth, there would be nothing to be said; but they do not, except in rare cases.

Depressing surroundings, damp and cold, business and domestic worries, injuries or shock, are constant factors noticed.

Provided that the cartilages are not seriously damaged and that the affected joints are not contracted, and set at an angle which strains the skin, something can be done to check the onward course. Contracted knee-joints are hopeless and largely due to neglect to keep the limbs straight during sleeping hours.

Local treatment must be assisted by constitutional treatment. As the strength is at a low ebb, salicylates, hot packs, Turkish baths, etc., should not be used except in the early stages. Numbers of chronic cases return home from the Spas, disillusioned and helpless cripples. Massage, which has never done any good in these cases, fails because it creates heat, and uric acid flies to an inflamed and heated spot and is deposited there. An injured (heated) ankle acquired exudations and caused a stiff ankle (cites a case). In a milder form the same thing happens in men of uric acid diathesis who ride much (quotes personal experience). The fingers of the left hand, holding the reins, get rubbed (massaged) by the horse's mane, and the knuckles of the hand become hot and then the seat of deposits. It is significant that the right hand escapes.

Ionic medication has fallen into disrepute due to faulty application, but properly applied, in conjunction with constitutional measures, it is the only means of dealing satisfactorily with rheumatoid affections. This medication must be concentrated in the affected joint. Tr. of iodine and carbonate of lithia give better results than any other agents. In light cases a course of from three to nine treatments every three to twelve months is given. Even this remedy, effective as it is in the majority of cases, is of little use in cases in which the cartilage is eburnized and the bones ankylosed.

Author recommends, in cases which resist this form of treatment, in which there is great pain, the use of his test for neuritis and treatment by his method described in the *Practitioner* for June, 1914. Where rheumatoid arthritis is complicated with neuritis, always treat the latter first. Syr. of Hypophosphites and Summer's Elixir of formate of soda to be used for exhaustion and in place of salicylates. Non-uric acid diet recommended. Environment an important factor. Ionic medication should be supervised.—*Thomas Madden Foley, Washington, D.C.*

MOBILIZATION OF BONY ANKYLOSIS OF THE KNEE-JOINT—ARTHROPLASTY. Charles Ogilvy. *New York Medical Journal*, November 16, 1921.

The majority of attempts to mobilize ankylosed knee-joints have proved

unsatisfactory and disappointing because in one group re-ankyloses resulted and in the other group extreme lateral mobility from the loss of the crucials and the sacrifice of lateral ligaments.

Author quotes Albee's surgery for historical sketch and gives technique of operation and end-result in a case of complete bony ankylosis of the knee-joint, resulting in a "normal functionating joint."

"With a very thin half-inch wide chisel, curved on the flat, the new joint was chiseled, in as close approximation to the old one as could be judged. First the outer half of the joint was freed and then the inner. No bone was removed, as is advised by Putti, as this, in my opinion, tends in part to cause instability of the joint subsequently." Author smooths joint surfaces with a fine-bladed chisel and a large curette, strips away only enough of the lateral ligaments to permit flexion to a right angle, secures interposed fascia lata with its fat to the lateral ligaments by one stitch on each side.

Knee was lifted slightly out of extension cast in two weeks, weight bearing was allowed in one month, patient was able to walk without the aid of crutches two months after operation.—*Thomas Madden Foley, Washington, D.C.*

THE TREATMENT OF IRREPARABLE NERVE INJURIES. R. I. Harris. *Canadian Medical Association Journal*, November, 1921.

Experience has shown that end-to-end suture of a divided nerve is the ideal method of treatment. Failure to restore function has occurred in cases where suture was possible, owing to several causes: (1) the quantity of scar tissue following suppuration; (2) axial rotation of the fragments, whereby proximal sensory fibrils have been united to distal motor fibrils, and *vice versa;* (3) pulling apart at the site of suture from (a) too much tension, (b) imperfect or too brief fixation; (4) wrapping the junction in fat, etc.; (5) metaplastic bone.

All cases where separation of the suture is the source of failure should be submitted to re-suture. In cases where the ends cannot be co-apted, and where from other reasons the lesion is deemed irreparable, much can be done. The use of bridges and nerve transplants has been clinically a uniform failure. In the arm the results of tendon transplantation have been brilliant, notably so in musculospiral lesions. By transplanting pronator teres to the extensors of the wrist, flexor carpi radialis to the finger extensors, and palmaris longus to the thumb extensors, 100 per cent. of cases are improved, and the majority can resume occupation even where this involves arduous work.

In the case of the median nerve, the resulting anæsthesia is more important than the paralysis in low lesions, and attempts to overcome this by suturing the radial to the median have given promising results.

For the paralysis of a high median lesion some of the extensor muscles, such as brachio-radialis, or abductor pollicis longus, may be utilzed by attachment to flexor tendons. In ulnar lesions, no remedial measure except amputation of an inconvenient digit is suggested.

In the lower limb stability is the desideratum, and tendon transference yields poor functional results. Stabilization operations on the foot are preferable when necessary. Complete sciatic paralysis usually entails less serious functional motor disability than does incomplete. For mal-positions due to imperfectly balanced muscle-pull, tendon fixations, *e.g.*, tibialis anterior to tibia and peroneals to fibula, have proved of service.—*Alexander Gibson, Winnipeg, Manitoba.*

ANATOMIC EVOLUTION OF THE HIP AFTER REDUCTION OF CONGENITAL LUXATIONS. Broca and d'Intignano. *Revue d'Orthopédie*, September, 1921, p. 353.

After reduction, the treatment of a congenital hip has for its end the re-forming of the joint to make it functionally useful. The orientation of the femoral head is changed and the acetabulum deepened by maintaining the leg in the most favorable position. In later stages of treatment, walking aids in accomplishing this end.

The original malformation is characterized by general thinning of the bone, anteversion of the neck and arrested development of the head. On the part of the acetabulum there is a lack of depth and the iliac portion, instead of forming a roof, ascends obliquely.

During the period of immobilization the object, from a mechanical standpoint, is not only to deepen the acetabulum by direct pressure of the head, but to reshape the head and neck by making a pressure in a varus direction. In case the acetabulum is already deep enough, the thigh is placed in such a position (extreme abduction and external rotation) that the ligament of Bertin (Bigelow) is on tension so that it holds the head up against the roof of the acetabulum. Furthermore, the ligament of Bertin, thus placed on tension, elongates so that it is possible to adduct the femur without throwing the head out. When this elongation has occurred and when the posterior part of the capsule, originally relaxed, has contracted enough to furnish some support, the second step in treatment is taken. This is at about three months and consists in bringing the thigh down about one-third from the position of extreme abduction and external rotation and giving it a little internal rotation. The patient then begins to walk with the leg held in this position in apparatus, the head of the femur continuing to deepen the acetabulum.

The conditions are quite different when the roof of the acetabulum is replaced by an oblique or even almost vertical wall. Then the head, after being reduced, slips out with the slightest attempt at adduction. By immobilizing in acute flexion and forced abduction, a mediocre deepening of the acetabulum is effected, but the results are not good. Although complete reluxation is rare, ascension and separation of the head are not.

Sometimes the reconstitution of the joint is perfect and one is unable to tell which was the affected side, either by the patient's gait or by the roentgenogram. Among 357 cases studied, about a dozen came under this cat-

egory. Almost always an osseous deformity persists even though the functional result is not compromised. This is usually a varus position either of the head alone (115 cases) or with a varus also of the neck (158 cases). This varus may be a right angle or even less, but the head, nevertheless, remains in the acetabulum. A persistent valgus is fortunately more rare, since, although it is compatible with a good result, it predisposes to reluxation or, at least, to ascension and separation of the head. In 52 cases of this deformity a progressive reluxation occurred in only four and an elevation of the head in 32 cases.

The remodeling, under the influence of walking and ossification, brings about a hollowing of the acetabulum and a rounding off of the head. The aspect may become absolutely normal (about twelve cases in this series), but in most instances abnormalities persist.

What has been said above applies to cases a year or two after reduction. Fifty patients (72 luxations) were examined eight or ten years after reduction. In general, these cases show a tendency toward normal form under the influence of corrected function. The neck, which in the first stages of treatment was in a varus position, later takes a more normal direction. In 18 cases there was observed a re-formation of a neck in valgus with a flattened head, giving an excellent functional result. It has been noticed that the late or secondary reconstitution of the joint is much less in cases operated a little late, after four or five years for unilaterals and after five or six years for bilaterals.

In general, it may be said that it is quite exceptional to have a reluxation if the head has remained in after several months of walking. Regarding the influence of age, it is interesting to note that in young children with bilaterals, the side first operated gives a better modeled joint than the second side which is of necessity operated about a year later.

Sixty cases are reported in detail and there are 106 illustrations reproduced from roentgenograms. These illustrations are so closely followed in the text that an abstract falls short of doing full justice to the paper. The number of cases studied and the manner in which they are presented give to this article an unusually high value.—*William Arthur Clark, Pasadena, Calif.*

WRITERS' CRAMP—ITS CAUSE AND CURE. W. H. Bates. *Medical Record,* Vol. 100, No. 10, September 3, 1921.

The author, who is an ophthalmologist, reviews the various theories of the cause of writers' cramp. He states that his practice has brought him in contact with a number of such cases. He has found upon investigation that in these cases the patient has slept with the hand or arm under his head, and that when this practice was corrected the symptoms very quickly disappeared. He cites three cases and states that he has never known a case of occupational cramp that did not yield to this simple treatment.—*A. O'Reilly, St. Louis, Mo.*

OBSERVATIONS ON THE NORMALLY DEVELOPING SHOULDER. Isidore Cohn, M.D., F.A.C.S. *American Journal Roentgenology*, January, 1922.

The study has been divided into three parts:

1. A review of the literature.
2. Observations based on a study of normal shoulder joint.
3. Descriptive findings of individual radiograms of normal joints of various ages.

The summary explains nineteen of the twenty-two plates illustrating the radiograms.

Conclusions: Radiologic examination of the shoulder girdle during the first year shows only one epiphysis sufficiently ossified to leave a shadow, the epiphysis for the upper end of the humerus. This epiphysis is represented by a small elliptical shadow, which is rather widely separated from the upper end of the shaft. Our earliest observation was seven weeks.

During the first two years no other epiphysis makes its appearance, except for a small shadow which may be interpreted as the early ossification within the coracoid process.

During the third year the head of the humerus increases rather rapidly in size. The upper end of the shaft takes on the appearance of a double inclined plane, higher near the middle and sloping downward to either side. At this time there is a shadow on the outer and lower aspect of the epiphysis for the head, which may be ossification within a separate epiphysis for the greater tuberosity or it may be that the greater tuberosity is a downward growth from the original epiphysis for the head. In the pictures no clear line of demarcation can be made out between the shadows.

Beginning ossification within the coracoid is evident at three years.

In order to avoid errors of interpretation in roentgenograms of the shoulder one must take several views.

Ossification within the epiphysis of the acromion is rarely evident before the middle of the fourteenth year.

Complete ossification of the acromion epiphysis takes place about the middle of the eighteenth year.

Complete ossification within the upper epiphysis is evident about the nineteenth year.

There is no trace of the epiphyseal line at the twentieth year.—*Thomas Madden Foley, Washington, D.C.*

THE CHALLENGE OF THE CHRONIC PATIENT TO THE MEDICAL PROFESSION. Joel E. Goldthwait. *Boston Medical and Surgical Journal*, January 12, 1922, p. 31.

When considering the subject broadly, it can hardly be denied that our profession as a whole has but little interest in chronic medicine or that the interest is distinctly less than it was a generation ago. The author states that our basis is one normal structure, *i.e.*, anatomy. Practically none of the

cases of chronic disease are of this normal structure. Not only do individuals vary in structure,—muscles, bones, viscera, and potentials of activity,—but considerable regularity of such structures carries with it its own potential of disease.

The author speaks of the low back condition which probably leads, more often than any other, to medical advice being sought for relief. This is not unreasonable when the great variations in structure are appreciated, together with the imperfect mechanics in use. The understanding of the types, shapes, and number of lumbar vertebrae aid in the diagnosis of low back pains. Some individuals are so built that the abdominal organs are relatively small, allowing a large range of comfortable motion, but to another person such range of movement would cause injury. The length of the intestines varies. Once anatomic features are recognized and the function of parts considered in the varying ways in which the body is used, it requires little imagination to at least see the possibilities of difficulty. Orthostatic albuminuria is often so called because lordosis is the essential feature in producing this symptom. It may not be indicative of serious functional disturbance, as generally believed by our profession. Also with the visceroptotic patient there is always more or less ptosis of the diaphragm, and since the flow of blood from the abdomen back to the heart is almost entirely dependent upon regular action of the diaphragm (milking the abdominal veins against the upward opening valves), it is fairly easy to believe that some of the abdominal symptoms or disturbances in the physiology are due to the disturbance in the circulation, resulting from the position in which there is inaction of the diaphragm. The latter can be easily demonstrated by fluoroscopic examination. The author speaks of cases observed in American Expeditionary Forces which were diagnosed D. A. H. (deranged action of the heart), and subsequent exercises, which favored the holding of the back erect, cleared up the heart symptom. The correction of the mechanical feature thus relieved the physiological distress and pathological manifestation.

The author discusses briefly the problem of the chronic arthritis and points out its complexity and disturbance of physiology. Bad teeth and tonsils should be removed as a hygienic measure. Most cases of chronic arthritis, however, are influenced by altered physiological conditions, existing in the abdominal viscera. The drainage of organs may be altered or the secretions too much or too rich or alterations in the balance favor the growth of bacteria. —*Voigt Mooney, Pittsburgh, Pa.*

OSTEOCHONDRITIS OF THE HIP, OR COXA PLANA. Is an Unrecognized Congenital Dislocation. F. Cabot and H. Colleu. *Press Médicale*, No. 4, January 14, 1922, p. 35.

Many theories of causation of this condition have been advanced, but Legg is the only one to have established a relationship between the lesions observed and the deformities that one encounters in reduced congenital dislocations,

but he has denied all connection between the two and even attempted to make a differential diagnosis.

However, judging by clinical and x-ray studies, the authors believe the condition to be a congenital malformation of the nature of a subluxation.

The reasons why this has not been recognized before are various.

1. We are not familiar enough with the notion that congenital lesions of the hip do not reveal themselves necessarily with the first steps or even in the following years.

2. We have not recognized that attacks of pain are important manifestations in congenital lesions of the hip.

3. One should not discard the theory of a congenital lesion being present because the classical picture of a dislocation does not leap before the eyes. The lesions present are border-line ones and can be recognized only with difficulty.

4. Especially must care be observed in order to recognize the anterior type of subluxation, because the flat x-ray plate does not give perspective.

5. It is also important to study the x-rays carefully, not only from the standpoint of lesions of the epiphysis, but also of the articular surface of the femur and acetabulum.

Clinical examination of a patient may reveal a history of the child having commenced to walk late and having had a slight limp from the beginning. This history is difficult to obtain as the parents try to hide congenital lesions. There is always slight limitation of abduction, and palpation may show the head abnormally prominent anteriorly.

The correct interpretation of x-rays of the hips is always difficult when one is dealing with slight differences. One must have a large experience to be able to recognize the normal, which is not often seen. There are many variations in the shape of the acetabulum and in these cases it will be found flatter than normal and the articular relations are abnormal.

The authors conclude that careful study of a number of cases of congenital subluxation of the hip will convince anyone that the condition known as osteochondritis, coxa plana, pseudo coxalgia, etc., is only a transitory phase in the evolution of a subluxated hip. The same congenital malformations of the hip later give rise in adults and adolescents to some of the lesions which are classed under the name of arthritis deformans.

In osteochondritis all the laboratory investigations from the point of view of syphilis, tuberculosis or infectious processes have been negative. Only the theory of a congenital lesion can explain logically the paradoxical observations which show that the observer is on the wrong track.

They conclude that it is necessary to revise a large part of our ideas regarding the pathology of the hip, and that when this revision is made, the chapter concerning congenital subluxations will be the important part.—*P. D. Wilson, Boston, Mass.*

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THE SPECIALIST IN SURGERY AND HIS VIEWPOINT.

BY NATHANIEL ALLISON, M.D., ST. LOUIS, MISSOURI.

Professor of Clinical Orthopaedic Surgery, Washington University School of Medicine.

Presidential Address before the American Orthopedic Association, Washington, D. C., May 1, 1922.

Fellows of the American Orthopedic Association, Guests of the Association, Ladies and Gentlemen: We are gathered together to hold the thirty-sixth annual meeting of the American Orthopedic Association. As your President, it is my privilege to bid you welcome. As your President, it is my duty to deliver before you the annual address. The thirty-five presidents of our Association who have fulfilled this yearly obligation before me have left a series of documents which may serve as an index of the moods, the hopes, and the anxieties of this honorable body. Therein lies a record of our aims, and of our success in attainment. Through these pages one may glimpse the problems of the infancy, the youth, and the early manhood of our special surgical work. One may observe the progress of this work, too, as it has kept pace with the growth of modern surgery. The impression is unavoidable that our

Association has had an illustrious career; that it has reached a vigorous maturity; and that the future still holds much that must be solved. It is this last thought that gives us pause. The past we know full well; admittedly we are chiefly concerned with our immediate present, but we must engage our thoughts with a vision of the future. In the nature of things youth is followed by maturity, and maturity by the gradual sclerosing processes that presage old age. Our strong young manhood has been gained, as the records show, by the evolution of a spiritual ideal associated with a practical purpose, and through this combination our particular type of surgery has become established as one of the departments of modern surgery; one that demands not only a special training, but also a special fitness; one also that includes the crystallization of ideas, that once were but dreams, into practical and well-established facts. But along with maturity has come a certain dogmatism and belief in an established order and a tangible creed. We are inclined to be ruthless with those who presume to question the truth of our beliefs and the validity of some of our creedal tenets. This mental attitude is no other than the normal state which comes with the gathering of experience and knowledge, and it signifies maturity. The thoughts of maturity may be longer thoughts than those of youth. It is with the hope that our Association may long continue to contain elements of elasticity and buoyancy, that we may forever stay the first stages of sclerosis, that I venture to address you as your thirty-sixth president. I have chosen as the subject of my address the following: "The Surgical Specialist and His Point of View."

This subject has become dear to my heart for I realize that to each and every one who considers himself a specialist in surgery there must come moments when he is inclined to question his whereabouts, both in their relationship to the progress of his own specialty and to the progress of surgery as a science.

As our specialty, that of orthopædic surgery, has progressed along the road of development it has accumulated about it certain tendencies that have grown to the size of creeds and fixed beliefs. I do not hold that our own specialty is peculiar in this matter. I believe it to be one of the evidences of growth and progress that adventitious issues tend to grow up like tares which may choke our better aspirations.

Of these, perhaps the greatest is an increasing evidence of self-satisfaction with our accomplishments; and how could this be otherwise when one looks back across the span of years and notes the facility with which things are now done that once were either difficult or im-

possible? On the other hand, it seems wise to point out that our fathers — the men who founded this Association — were concerned with the treatment of the same conditions that we are now called upon to care for surgically. These men who banded together to form this Association were men, in most instances, of extraordinary attainment. They felt it necessary to join together because of the mutual improvement and satisfaction gained by discussing their difficulties. We are inclined to assume an attitude of self-satisfaction when we look back upon their methods and their results; but are we entitled to this self-admiration? I may mention that the clinical conditions which gave the founders of this Association their *raison d'être* included, among others, lateral curvature of the spine, congenital dislocation of the hip, the infectious arthritides, and the residual paralyses that follow anterior poliomyelitis. One may ask how far we of the present have traveled toward the solution of these problems, and where do we stand relative to the past generation as far as gaining a definite solution is concerned? One may point out that we are entrusted with this solution both by our colleagues in medicine and by the laity. Indeed, it is our chief reason for existence today as surgical specialists, and much of our future use in medicine depends upon the way in which we work to alleviate these and similar conditions which human flesh is heir to. If we have not the scientific imagination and the inventiveness to do this, there will surely arise some one else who will. My own self-satisfaction suffers much when I consider these facts, and I feel that much good may come to the soul of our organization by an occasional self-examination of this nature, ungracious as it may seem to mention it at our annual gathering.

Another of our tendencies is the expressed desire to fence about our special field in surgery and to indicate that he who wanders beyond its barriers is out of bounds. Perhaps it were better to think that there is nothing on the whole range of medicine that is branded as belonging to any one or to any group, and that only through strong competitive struggle are men developed who look upon scientific attainment in the proper way. If our specialty in surgery is to become routinized and compressed within narrow boundaries, then will our specialist be a narrow man and our Association will no longer be mature, but will be old and settled. It is possible to cite many examples of the effect that this narrow specialization and these limiting boundaries have had upon those engaged in other special fields in medicine and surgery.

Along this line of thought also there has come up recently a new

tendency—one that may be termed that of smug standardization. This notion got its start from our participation in the last war. It was necessary during our military effort to use large groups of untrained men for special duties, and certain rule-of-thumb methods were devised to take care of emergencies that must be met. In consequence, standard methods of doing things in the quickest and most effective way were adopted. It was necessary to plan these methods so that they would be "fool-proof." Perhaps there is nothing worse that could happen to our special type of surgery than the growth of a limiting idea. It is not for us to dim the spark of the investigative spirit, to set it, to splint it, or to hold it under control. Rather let us seek to build up a spirit of non-conformity, using non-conformity in its better sense. Surely we do not desire the perpetuation of our faults. If our young men are to be no better than we are, if our future is to be no broader than our present, then our specialty is at once old and dead. Perhaps this outcropping of a desire for standardized methods is the first symptom of the passage of our specialty beyond the age of maturity.

To those of us who hold dear the position of our Association in surgery, there comes another thought which is not new, but which I dare not pass over without mention. We are constantly tending toward a belief that we may allow men to become surgical specialists without first being trained as surgeons, and with this also runs hand in hand the idea that a special part of the surgical field may be greater than the field of surgery itself. President Vincent recently said that it is the specialist's best attribute that he is inclined to believe that all the world rotates about his specialty. I, too, believe in this enthusiasm, but I would demand that the background for it be secure. Surely we have grown old enough and important enough for our work to stand upon its own merits; surely we must believe that much of this security is dependent primarily upon the ability to do surgical work as well-trained surgeons and not as narrow specialists.

Perhaps orthopaedic surgery has in this regard reached a parting of the ways. One path leads to narrow specialization with smug standards and lack of broad vision. It is a simple matter to train men for this type of surgical effort; there need only be fulfilled a set of definite requirements and the men trained will soon be capable of carrying on to their own satisfaction and the satisfaction of their fellows. These men will be alike — an established type. The other path leads to what seems to be a future of greater achievement. Men who enter this path must be broadly trained. The whole of surgery must be theirs. They

shall have the desire to add to their general qualifications that of a special interest and a special opportunity which will utilize their special fitness. They shall not be men alike in mind and outlook. For such a group as this the future will hold no limitations and our Association, manned by such a personnel, will continue to advance with the procession of modern surgery; not following, but leading.

So much am I convinced that we should follow this broader path, that I would urge the serious consideration of attracting men to our Association and including in our membership those who have an especial interest in the surgery of the extremities and spinal column, but who are frankly not to be considered as surgical specialists. Our Association needs this transfusion of new blood. This type of surgeon needs the encouragement offered by such a body as our Association. Some one has divided all surgeons into two classes — carpenter and plumber surgeons. Our Association should represent the best interests of the carpenter surgeons. Surely we have not come thus far along the path of progress to find ourselves halting in our efforts at future achievement. Let it be set down as most hopeful that our Association has reached a period of security wherein it can justly consider its past, rightly estimate its present status, and hopefully dream of what it may accomplish. I firmly believe that grandeur is so nigh our dust that the youth of our Association will hear more vividly the whisper of idealism and that we shall always acclaim a broader and braver viewpoint.

CHRONIC ARTHRITIS.

BY LORING T. SWAIM, M.D., BOSTON.

Arthritis has been divided into three groups by Goldthwait, Painter, and Osgood[1]: the infectious, the atrophic, and the hypertrophic; by Nichols and Richardson[2] into two: the proliferative and the degenerative; and by the English[3] into rheumatoid and osteo arthritis. This has been, and is generally, accepted today. Of late, the infectious and atrophic cases have been grouped as one disease. The reason for this paper is that from the clinical, pathological, and x-ray study of these groups certain definite differences can be noted, and because of these differences the infectious and atrophic would seem to be entirely different entities, varying again from the hypertrophic. The museum specimens of these groups are not at all alike, the x-ray pictures are quite different, and the clinical onset, symptoms, and signs are also very unlike each other. A clearer conception of arthritis is being reached, but there is still much dispute. We are in the clinical study stage in regard to these diseases. We do not know that these groups are caused by the same agents. In fact, the clinical symptoms and x-rays all point to a different cause in each type, or at least to a very different reaction in different persons. Recently, much attention has been called to the study of arthritis by the work of Dr. Pemberton,[4] and the recent communications of Dr. Ely[5] have aroused interest, and more writings on chronic arthritis are appearing. It would greatly facilitate the future study of these baffling diseases if the kind of arthritis were specified in connection with the observations, x-rays, clinical etiology, and treatment. This may, in time, lead us to the causes, prognoses, and correct treatment of the chronic arthritides. To bring out this difference in type this paper has been written. Following is a brief review of our knowledge of the groups of arthritis from a clinical standpoint.

INFECTIOUS ARTHRITIS.

Etiology. Infectious arthritis is the result of the spread of some focus of infection, usually from some point in the alimentary canal or the genito-urinary tract, more rarely from some abscess outside this

mucous membrane system. Starting from the mouth, the chief localities for chronic infection are the teeth roots, tonsils, sinuses, gall-bladder, appendix, and in our experience, the cecum and large intestine are by far the most common sources of absorption of bacterial toxins or the results of their action on food residue. From the genito-urinary tract we have gonorrheal infections of the prostate, pyelitis, and infection of the seminal vesicles, all of which may produce an infectious arthritis. Endometritus, inflammation of the Fallopian tubes, may cause arthritis, but rarely will vaginitis produce infection.[6] These infections vary in intensity from the suppurative to the mild toxic symptoms of stiffness only. This is dependent on the virulence of the bacteria, the general resistance at the time of infection, and the number of joints involved.

The onset of joint symptoms may occur shortly after the acute local infection, or if the general resistance is good, a low-grade focal infection may be latent, yet can produce joint symptoms years later after some severe illness or if the body vitality is lowered by exposure, fatigue, or malnutrition. Age and sex seem to play no part in the incidence of the disease. It is seen in childhood as Still's disease, or may reappear later after an acute rheumatic fever. It is possibly more frequent in damp climates, where all throat and sinus troubles are prevalent or where exposure to chills is always an important predisposing factor.

Clinically, the history is that the joint or joints swell, become painful, tender, and hot, a few weeks after an acute infection, such as tonsillitis or a cold, for example. The joints show the typical signs of infection, heat, swelling, and tenderness, the capsule is distended with fluid, joint motion is painful, the temperature is elevated more or less, depending on the extent of the involvement and the acuteness of the infection. Again, the toxic or infectious symptoms in the joint may be very slight and intermittent over a long period, showing chiefly in periarticular soreness, stiffness, and slight chronic thickening. In such a case the chart shows a slightly elevated temperature over a considerable period. There are marked fluctuations. The blood shows secondary anemia and, as Pemberton has shown, a low sugar tolerance, as manifested by high blood sugar.[7]

There is no particular joint distribution in infectious arthritis. Any joint is susceptible, the disease may be monarticular or periarticular, and the joints involved may vary from week to week in mild cases. The history of the month before the first joint symptom is of great

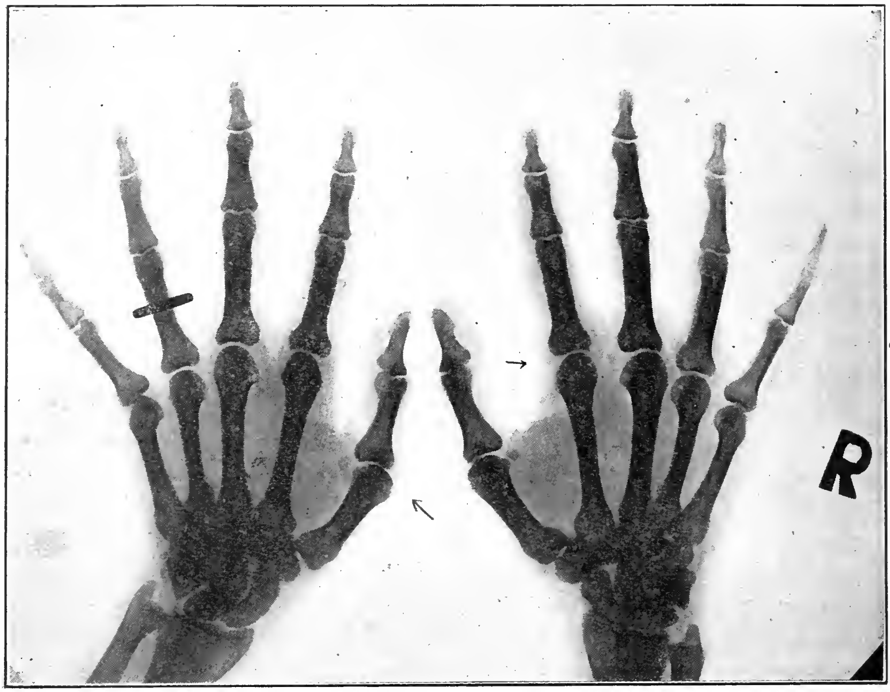

Fig. 1.—Infectious Arthritis. The left metacarpophalangeal joint of the thumb has been swollen, hot and painful for four years. Recently the first metacarpophalangeal joint has been swollen. The capsule is distended. There is no bone atrophy, no cartilage erosions, no bone changes. The infection is periarticular.

importance, as it frequently points to the area to be investigated for a focus. Often, however, there is no evidence to work with and the only course open is a painstaking search. After a supposed focus has been found and removed, the infection has undoubtedly produced more foci, and the only procedure is to increase the general resistance to the unknown focus. The end-results are a thickened capsule, adhesions, with fibrous ankylosis, dependent on the acuteness of the infection.[8] In mild cases frequently there are no signs of damage except periarticular thickening and no symptoms except stiffness during barometric changes.

In most instances it has been impossible to demonstrate the existence of bacteria in the affected joints,[9] but they have been located in the deep layers of the synovial membrane. Pathologically, we find fibrous and synovial capsular adhesions. In some cases the joint cavity is ob-

literated, there is marked hyperemia, and marked evidence of chronic inflammation in the fat tissue about the joint. The joint fluid varies from an exudate to pus. The cartilage may show inflammatory erosions. There are no bone changes found.[10] The x-ray findings are those to be expected from the above description. There is periarticular capsular thickening, fluid increase with distention of the capsule, joint cloudiness, but no bone changes except those of slight general atrophy from disuse. (Fig. 1 shows a hand, four years after first joint symptoms. This is believed by the writer to be a typical infectious arthritic case.)

ATROPHIC OR PROLIFERATIVE ARTHRITIS.

The second type of arthritis is the proliferative of Nichols, or the atrophic of Goldthwait. In many respects the name "atrophic" seems better from a clinical standpoint, because the x-rays usually show clearly atrophy of the bone structures, whereas the proliferative refers to the soft tissue changes, which are not shown by x-ray and are not, therefore, demonstrable in a living patient. This joint disease seems to have certain features peculiarly its own, making it a clinical entity. Whether it is due to infection we do not as yet know. The present clinical evidence and its characteristics are against this view. In our experience atrophic arthritis is atrophic from the start, and remains so. Infectious arthritis is infectious from the start, and does not develop atrophic changes.

The etiological factors are these: atrophic arthritis is found everywhere. It is a disease of early middle life, rarely occurring before twenty, and is by far more common in women than in men. It appears to be more common than the other types, and from our experience is increasing in proportion to the others. A notable fact about this disease is that it is almost exclusively found in the moderately slender anatomic type,[11] the so-called visceroptotic person, characterized by light bones, loose abdominal organs, short small intestines. They are subject to nervousness and malnutrition, and under nervous strain show decided evidences of instability, both mental and physical. It is not more common among the poor than the well-to-do. It is associated with nervous and physical strain, more often the former. Nervous shock is a predisposing factor. It is usually polyarticular and involves the smaller joints.

Clinically, atrophic arthritis is slow in its onset. The first symptom

in many cases in our experience is a vasomotor phenomenon, occurring in the fingers. One or more fingers become pale, slightly numb, and a little painful, or rather "tight." This local vasomotor contraction may be momentary or last for some time. It is not related to temperature, occurring on hot summer days as well as in the winter, but it is more common during chilly, damp, or foggy weather. It is not infrequent at night. This phenomenon may be of frequent occurrence or may occur only during fatigue or strain. It has been observed six months before the x-rays showed any bone changes. Its significance is not known, and whether it is a factor producing endarteritic changes found in this disease cannot be stated. Its causes are probably nervous. It is in some cases a very transient symptom and is frequently overlooked by the patient. Attention was called to this before. Shock is a frequent point in the history; excessive worry and unhappiness, fear, and nervous strain often precede the first symptoms.

Characteristic general symptoms are depression, mild fear, instability. There is malnutrition of the muscles and skin, as well as atrophy of the bone. Chronic fatigue is common. Pain is not an early symptom, and it may be lacking for some time after the joint enlargement appears. The temperature instead of being above normal is usually subnormal. The blood pressure is commonly low. The pulse is frequently rapid and small. The appetite is poor and the weight is subnormal. An almost constant clinical feature is the acid saliva. Blue litmus paper is turned red. The tongue has a clean, red, wet appearance. The gums are often soft, spongy, and bleed easily. They show marked retraction and are sore. They strongly resemble the gums found in mild scurvy cases, where food deficiency is a factor. Quite frequently no focal infection can be demonstrated, and the results of the removal of teeth and tonsils have been disappointing in the atrophic cases.

Clinically, the small joints early show widening of the joint with a soft tissue swelling. There is abnormal mobility of the joint laterally. In the hand the finger is shortened by the destruction of the underlying bone and cartilage until all resemblance to a joint may be lost. (Fig. 2.) The dry crepitus felt in such a joint means cartilage destruction and loss of synovial fluid. Bony ankylosis is the end-result. Deformity is the rule in atrophic arthritis. The disease is progressive with remissions, unless proper means to offset its course are taken, or nature asserts itself.

The visceral studies in atrophic arthritis are in accordance with the

FIG. 2.—Atrophic Arthritis. Late stage arrested. General bone rarefaction, especially at joints, in carpus; complete destruction of metacarpophalangeal joints, bony ankylosis of some of the phalangeal joints. Some of the phalanges have become bent. There are no hypertrophic spurs after ten years.

anatomic type of the patient in whom this arthritis is most commonly found, that is, the visceroptotic type with the tubular, low stomach, short small intestines, and the low, loosely attached cecum. There is quite often cecal stasis, with a tendency to spastic constipation. With this type of anatomy one finds great variability of the gastric and intestinal function, both motor and secretory. Colitis is common in this anatomic type and is frequently found in atrophic arthritis. There is fermentation, gas, and quite often foul stools with considerable undigested food particles present. Colonic irrigation, or castor oil, or a radical change in diet will many times give relief from joint soreness. Menstruation often has a decided effect on the joint symptoms as well as on the whole

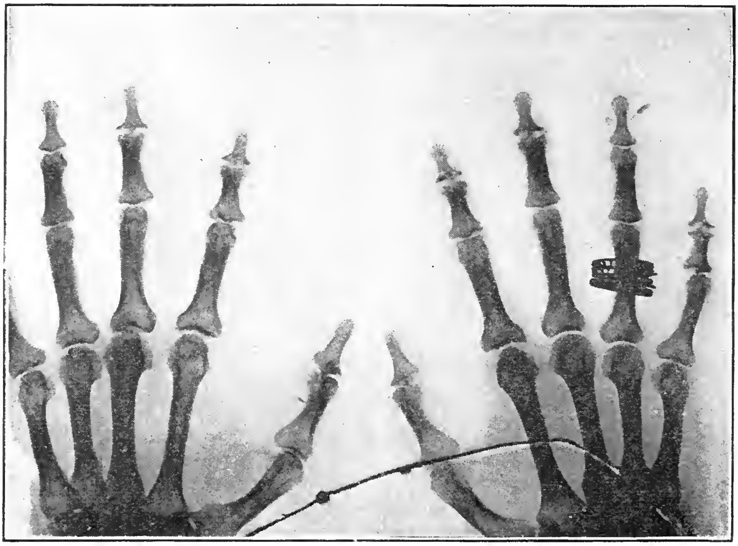

Fig. 3.—Atrophic Arthritis. Two years old. 1916. Note the general bone atrophy, especially about all the joints. Some still show cartilage with atrophy below it; in others it is gone; mushrooming has occurred at the terminal phalanges. There are no spurs being produced. The bones are almost porous.

physical condition. The joints are apt to be swollen and more painful at this time, and are better between periods. There is more mental depression.

Pregnancy usually improves the atrophic arthritic during the gestation, but after delivery the joints are frequently worse and show decided increase of the bone atrophy. A possible explanation of this is that during pregnancy the demand for bone salts is increased. In the atrophic case these salts are at a premium, and since the rule is that the child shall not lack, the result should show a greater bone atrophy after pregnancy. This is often the case. There is, however, another explanation. It is that during the pregnancy the enlarged uterus gives such perfect support to the low viscera that metabolism is better than at any other time. After delivery, this sudden withdrawal of the support correspondingly makes the bone phys ology worse. Both may be factors. In a number of cases atrophic arthritis has occurred after pregnancy or miscarriage.

Nervous symptoms are more frequent in the atrophic patients. They are normally high-strung, as is common in the slender anatomic type,

FIG. 4.—Same case as Fig. 3, one year later, 1917. Note the changes in the terminal phalangeal joints. They have become atrophied away, and the fingers have shortened and the mushrooming has increased. Note especially the changes in the second finger on right hand and little finger on left.

especially so in women. They frequently have undergone some severe nervous strain prior to their arthritis and they show more depression and fear than either the infectious or hypertrophic arthritics. This nervous tendency may have its effect through the glandular system, as Cannon[12] has clearly demonstrated the effect of fear, shock, etc., on the suprarenals. Skin changes in the later stages are common. The skin is also rather non-elastic, staying wrinkled when pinched up. Later the skin of the hands becomes smooth, shiny, and polished. The finger nails show deformity, probably due to interference with the matrix of the nail, as a result of bone changes or to general atrophic changes noted in all parts of the body.

An interesting condition is frequently found in the mucous membranes of the nose and throat. They show atrophic rhinitis. The atrophic arthritics often become fat after the active stage is passed.

From the foregoing observations it would seem a reasonable deduction that these atrophic arthritics have a decided physiological disturbance with insufficient stability of their metabolic processes to affect near-

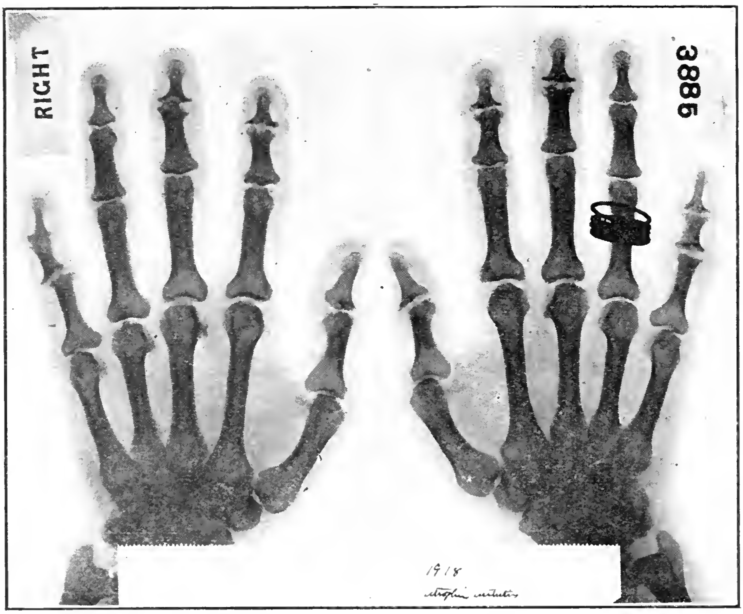

Fig. 5.—Atrophic Arthritis. Same case, one year later, 1918. Note more bone atrophy and absorption, 2nd finger right, little finger left, and left thumb. Ankylosis of terminal joint of the little finger, right. Symptomatically, the disease had remained quiet. The x-rays showed destruction, but less bone rarefaction.

ly all parts of the body as well as the joints. The picture is one of malnutrition of the bones, muscles, skin, mucous membranes, and nervous system, with a low blood pressure and vasomotor instability. It resembles a nutritional disease, the joint disease being only part of the picture.

The pathology of these joints is interesting, as described by Goldthwait, Painter, and Osgood.[13]

The synovial membrane becomes congested with villous formation and excess of blood-vessels. The fat is increased. The fibrous tissue gradually increases with more fat. Endarteritic changes occur and there is less blood supply. Finally the tissue resembles that of a scar. These changes are very slow. The cartilage loses its glistening healthy aspect and becomes duller, striated, and thinned out, with finally non-inflammatory erosions. The cartilage is replaced gradually by fibrous tissue. The bone is eroded, as is shown clearly in the serial x-rays. (Figs. 3, 4, 5.) Bony ankylosis is common. A note in this connection is inter-

esting—the bone atrophy frequently seen at the end of an arteriosclerotic artery. No bacteria have ever been demonstrated about these joints. The process seems to start in the bone and destroy the cartilage from below the joint, as opposed to infectious arthritis, which begins in the joint.

The roentgenological examination shows apparent widening of the joint, suggesting a mushrooming out of the soft atrophic bone. The digit is shortened or deformed by the bone destruction. After the erosion has proceeded far enough to bring raw bone surfaces together, bony ankylosis occurs. This bone destruction can be followed by serial x-ray plates and has been observed without any inflammatory reactions present on examination of the joint. There is often no pain during the destructive progress of the disease, as shown by x-rays. Serial plates are the only guide to the therapeutic control of the disease, as these alone show the actual bone changes taking place.

HYPERTROPHIC OR DEGENERATIVE ARTHRITIS.

The third type of arthritis is the hypertrophic, or degenerative.

Etiology. It occurs in older people, as a rule beyond middle age, or in those who show signs of premature old age. Hypertrophic changes are associated with trauma of the joints and are often monarticular, as opposed to atrophic, which is rarely monarticular. It is most frequent in the knees, fingers, hips, spine, shoulders, and feet, depending often on the occupation. On the other hand, it seems quite probable that trauma decides the locality, and a diathesis is responsible for the bone changes. Hypertrophic bone changes are an accompaniment of old age in the heavy anatomic types, being frequently found in the gnarled fingers and stiff back of these people.[11] It is rarely found in the slender type of back. It is more common in men than in women, probably due to a more exposed life of strain and trauma.

Clinically, it is as a rule painless in its onset, the bone changes being found quite well marked in joints which have never given any symptoms. It is frequently a cause of joint pain through mechanical irritation and trauma of the spurs. There are no vasomotor phenomena. There are rarely any acute local symptoms such as heat, redness, or tenderness. The temperature is not affected. The patients are of the heavy anatomic type: thick, heavy bones, large, high stomachs, long small intestines, and the big caliber large intestines. This is the sluggish digestive type, with the flaccid constipation and bulky stool. The acquired

sag of the heavy stomach and intestines is frequently found associated with hypertrophic arthritis. As is common in the heavy anatomic type, arteriosclerosis and high blood pressure are often present. In this type one finds the tendency to sluggishness, over-weight, slow pulse, many of the signs of hypothyroidism, such as dry skin and hair, brittle finger nails, with constipation of the flaccid variety.

The traumatic hypertrophic joint is usually monarticular, such as the hip, the pain being due to the original trauma, later kept up by the resultant hypertrophic spurs. Trauma does not necessarily mean acute trauma, but may be the result of long-continued strain of an improperly used joint. This is frequently found in the knees and the lumbar spine, the changes having been the attempt of the body to prevent strain. One of the chief causes of these chronic strains is faulty body mechanics. Again, in old people the bone changes occur slowly, painlessly, and without any inflammatory reaction at all. Frequently the physician is never consulted in such cases. Again, cases with very extensive hypertrophic bone changes come to the physician for other causes and the arthritis is found in the process of examination.

This all goes to show that hypertrophic arthritis is quite different from the other two types, and is a slow, painless process which is so gradual that often no symptoms are noticed by the patient locally or constitutionally.

The hypertrophic arthritis is extremely rare in the slender anatomic type, as compared with the frequency with which it is found in the heavy type.

In a general examination these patients show certain signs of hypothyroidism. They tend to gain weight, the hair and skin are dry, the finger nails brittle, and most of the bone changes unassociated with trauma occur after the menopause, when the appearance of general physiologic retardation is much more rapid and noticeable. Apparently all the body chemistry is at a very low ebb. The pulse is slow and full, the blood pressure increased, the digestive tract is slow, muscular activity is decreased, the weight is gained easily, and the mind is less active. Basal metabolism tests are below normal.

The Pathology. The synovial changes are slight, the joint cavity is usually normal in appearance except in spots of hypertrophic cartilage and villous formation. There is no increase in the vascularity and rarely an excess of fluid. The cartilage is irregularly hypertrophied, especially at the joint margin, and is easily felt on palpation of a knee, for example.[14] The cartilage is not striated as in atrophic arthritis. The

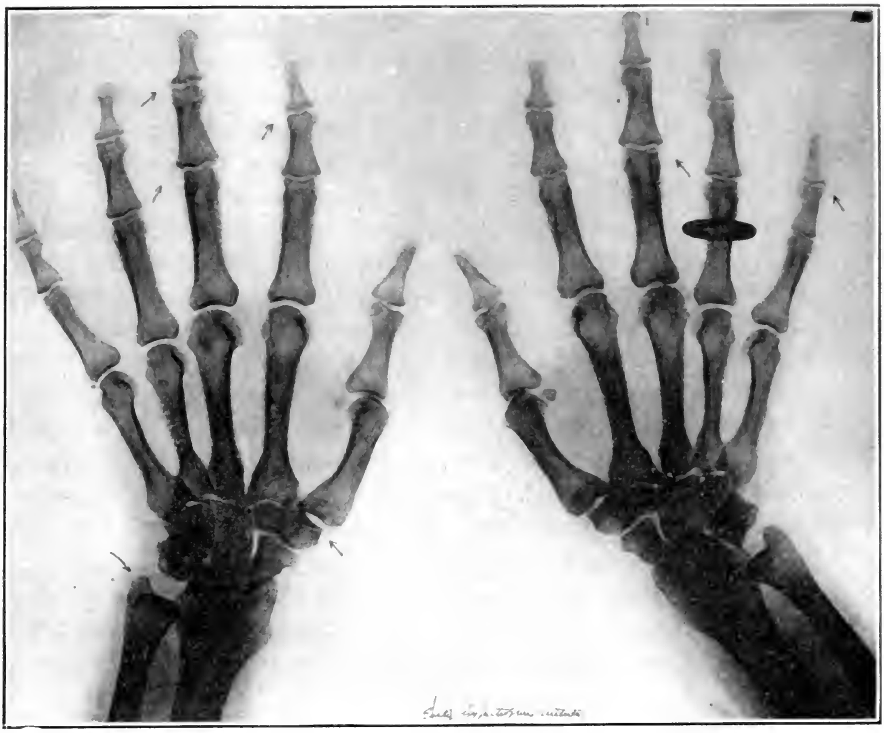

FIG. 6.—Hypertrophic Arthritis. Note the bone spurs on the terminal phalanges following the line of the capsule. No atrophy of the phalanges or carpus as seen in Fig. 3.

microscopic examination of the cartilage is described as overgrown with rapidly growing cells, and the synovial membranes have more fat cells than normal. The erosions found are not inflammatory, but have the appearance of mechanical erosions, differing in this respect from the infectious type and also from the atrophic erosions. The x-rays show no atrophic spots in the bone substance. There is almost no soft tissue swelling. The growth of the spurs is from the cartilage margins as a rule. The whole bone is as solid as normal, or even a little more so. (Fig 6.)

From the foregoing brief review of the types of arthritis it would seem that they differ from each other quite markedly in many important ways. If infection is the cause of all these types, then the kind of arthritis produced is dependent on the tendencies inherent in the individual victim. In other words, as we have previously attempted to show, the atrophic arthritis will occur in those patients having the predominant

characteristics of the slender anatomic type. Hypertrophic arthritis will occur in those who have the heavy anatomic characteristics chiefly marked.[11]

As has been repeatedly shown, the slender anatomic type has viscera which pass food on rapidly, especially in the small intestines, where the chief part of food absorption takes place. In this type there is not only the rapid peristalsis to be considered when functionally upset, but the small intestine is actually shorter in length, making nutrition a difficult matter at best, but more so when any functional derangement is added. Again, this type tends toward cecal stasis, due to the loose redundant cecum and free hepatic flexor almost constantly present, the tip of the cecum often being over the brim of the true pelvis out of reach from the front, as is seen in x-ray studies. The cecum is frequently tender, suggesting a state of congestion which would make absorption of toxic substances not only possible, but probable. Therefore, malnutrition in the slender type is common, and is inevitable under conditions of improper food and functional disturbance.

This malnutrition, as has been shown, is present in the atrophic cases only. The bone atrophy is general throughout the body and in all parts of the bones, particularly in those which are small and which have the poorest blood supply, such as the hands, feet, wrists, ankles. The first signs of atrophic arthritis are seen here. This is strongly suggestive that these bone changes are only part of a constitutional disturbance, the result of physiologic failure to supply bone nutrition in a type of individual already weak in this particular. Bacteria may cause this, improper food may be the cause, or improper function of the digestive organs or internal glandular disturbances, resulting in deranged chemistry of bone salts. All may be factors in some cases. My experience has been that removal of infection alone has very little effect in this arthritis, while very marked results can be produced by visceral readjustment.

The hypertrophic arthritic changes are an accompaniment of disturbed physiology in the heavy anatomic type, and seem to be an exaggeration of the normal tendency to heavy bone growth. The heavy anatomic type is less flexible than the slender type, because of the shape of the bones and because of the heavier musculature. Under strain or trauma of a joint, nature tries to limit motion and ultimately tries to lock joints by bony bridges, starting from the point of irritation. The periosteum in this heavy type becomes very active and repairs bone injury with heavy bone growth.

Under functional derangement this type seems to be retarded in its normal physiology; not only the lime salts show this retardation, but in other ways, such as gain in weight, increased blood pressure, slow pulse, sluggish digestive tract. The reaction to inactivity, as a result of pain in this type, is retarded metabolism as opposed to that of the slender atrophic type, whose activity is almost essential to better health.

A rather significant observation in the comparison of these three seemingly opposed joint troubles, and one which strengthens the belief that general physiology has much to do with the bone disease, is that during the menstrual period in the atrophic, the joint trouble is decidedly worse, whereas in the hypertrophic and infectious case little effect is produced. It is true that the slender anatomic type is more subject to menstrual disturbance than the heavy type. Pregnancy has no effect on the hypertrophic joint, whereas the atrophic joints are better during the increased physiological urge of pregnancy, but distinctly worse when the demand for better metabolism is removed.

This discussion leads to the point which seems of very great importance in the treatment, which is that these types of arthritis should be differentiated and treated according to the types for the best results. In the infectious group the bone salts are apparently handled without difficulty. The atrophic either does not get them in his food in sufficient quantities or is unable to handle them normally, due to physiologic disturbance, whereas the hypertrophic has an overabundance of capacity to handle them. It would seem, therefore, that in attacking these problems this should be considered. The tendencies of the anatomic types should be a great help to diet, exercise, general hygiene, and guidance back to health. Many cases of all types have spontaneously ceased to progress without aid from the medical profession, through some change in the resistance, functional capacity, immunity, or whatever we care to call it. We should, therefore, not alone direct our attention to the removal of foci of infection, but should do all in our capacity to raise the resistance, promote normal function, and control the chemical intake and regulate the life of the patient until health is regained. We cannot, of course, completely repair the damage done, but reconstruction should be attempted after the active stage has been controlled.

TREATMENT.

Treatment in each case involves two parts, the medical and the orthopaedic. They are so closely interwoven that they cannot be separated.

The medical deals with the arresting of the disease. The orthopaedic deals with the prevention and correction of deformity, leaving the patient in as nearly normal functional capacity as is possible. It is in this last capacity that medical and orthopaedic treatment can run side by side, because normal body function is impossible without normal body mechanics. The abdominal viscera cannot act to increase resistance with the stooped posture so frequently present in these patients.

It has been our experience that correction of body mechanics has been sufficient in some cases to turn the scale in favor of the patient and stop a downhill course. Again, it is only one factor, and the diet has to be suited to the weakened functional capacity, as Pemberton has shown.

It has been my experience that halfway measures with these arthritics, of whatever type, are unsatisfactory. They should all come to a hospital for study before active rational treatment can be undertaken. If impossible, they should be seen very frequently in order to locate the infection or control the diet or correct the body mechanics and general activity. Above all, the patient must be made to understand the meaning of coöperation. This can be done in a large hospital clinic, provided individual attention is given to each case. Unless such attention can be given, the case should not be undertaken.

The infectious arthritic must be painstakingly overhauled for local infections, chiefly in the alimentary tract or the genito-urinary tract. If these can be located through the history prior to the attack of joint trouble and on physical examination, the prognosis in early cases is exceedingly good. Later, it is a very difficult matter to eliminate the source, because it seems probable that subsidiary foci are started, like metastasis in malignant disease. Pemberton has given us a powerful weapon in these cases through his dietetic management.[4] Another is the increased elimination of intestinal waste and the effect of purgatives, as castor oil periodically, together with irrigations, and the increase of intestinal activity through massage, the promotion of general metabolism through baking (complete), and hydrotherapy. Locally, during the acute inflammatory stage these joints should not receive active or passive exercise. Protection, warmth, and any application which gives local relief is indicated. The salicylates should be employed sparingly. After the acute stage, active motion which does not stir up the joint to inflammatory reaction is to be encouraged, because the resulting stiffness will be less. Later, forced exercise of the stiff joints, or manipulation may be necessary for the restoration of function, but this most emphatically should not be undertaken for a long time after

all active arthritic signs have gone. The use of vaccines and non-specific proteins has met with no favorable results in my hands.

The tendency after removal of the infected tonsils, for example, is to sit back and wait for results. This cannot be too strongly warned against; in the first place, because it may not be the cause, and in the second place, much permanent damage can be produced in a joint shortly after the stirring up of a source of infection. The eliminative treatment should be pushed at this time and more care taken then than before or after. It has been my practice to prepare a patient most carefully for removal of an infectious focus, even waiting some time until the body has acquired greater resistance through building up, rest, exercise if possible, before subjecting him to a large dose of toxin, when he has already been seemingly overwhelmed. I believe it makes for less permanent damage in the long fight.

Patience and time are two indispensable factors in recovery. Dogged determination in the physician and patient is necessary. Brilliant results at times are seen, but in most cases it is a long battle with frequent discouragements. Occupational therapy is a great asset to the physician, because it not only helps to limber stiff joints, but promotes better morale during the long days of expected results.

In the atrophic arthritic, as I have attempted to show, we are dealing with a more complex problem. My experience with regard to foci of infection in this group is very discouraging, so much so that it has made me skeptical as to the infectious origin of the disease. On the other hand, attacking the problem from the anatomic type standpoint has given much more satisfactory results. Remembering the general state of lowered vitality, malnutrition, and functional visceral disturbance, the diet has been normal in amount, even increased by small quantities between meals. Often these fish-hook stomachs will stand only small quantities at a time and require frequent meals. The diet should be well balanced, with plenty of fruit, such as orange juice, and fresh green vegetables for the mineral salts in them. It has been our experience that the sore gums, retracted and red, improve with orange juice, much as if they were the gums of the scurvy patient. The diet must be simple, not rich, and not highly spiced, as these patients tend to hyperacidity and gastric irritation. There should be enough green bulk to give the intestines material to work on and to push through the cecum. This, with massage of the cecum, will help to correct a cecal pocketing

at the redundant sagged tip. Massage also helps to alleviate the congestion and tenderness in the lower right quadrant.

Much still remains to be found out about the food problem in these cases, especially as regards the lack of mineral salts of our highly refined foods, such as cereals and starches, sugars, etc. This may be the reason for the bone salt deficiency in these cases, as well as the general nervous and epithelial malnutrition found. (We can make no statements as yet.)

The next problem is one of increasing the patient's capacity to utilize food. The patients have a struggle to gain weight even when not ill. The amount ingested seems to make very little difference to them. The trouble is more fundamental than calories; it is a question of functional capacity. The problem is one of body mechanics, as it is in all slender congenital visceroptotic people. The viscera cannot handle food successfully if the diaphragm does not pump back the venous blood supply; the liver, spleen, pancreas, kidney, and especially the small intestines, cannot do their work if handicapped by downward pressure, congestion, and mechanical kinking present when the body is improperly used.

Body mechanics, as shown by Brown,[15] Goldthwait,[16] and others,[17] is a tremendous factor in the functional derangement of the viscera and nutrition. Consequently, it has been our practice to begin correction of body mechanics, such as round shoulders, relaxed abdomen, sagged back, contracted ribs, etc., at first by recumbency, during which body exercises, such as breathing, rib stretching, abdominal stretching, abdominal exercises were employed; later, with active standing corrective exercises and, if necessary, corrective apparatus.

It has seemed that little could be done locally for these atrophic joints except to promote circulation, though hyperaemic, with heat, massage, packs, etc. Medicinally, we have used chiefly soda bicarbonate, with good results apparently. Its use has been empirical because of the acid tongue. Not infrequently soda has acted quite as well as aspirin in relieving pain, giving better nights, and clinically has helped reduce congestion of the joints. Medicinal tonics and stimulants have appeared to be of no permanent value except as appetizers. The mineral salts apparently have little effect in their present chemical forms.

The orthopaedic care of these joints presents many problems, because of the tendency after cartilage destruction to bony ankylosis. The more motion a patient can keep during the active stage, even if it produces

congestion, the greater the advantage. These patients should not remain quiet long, but should be encouraged to activity as far as compatible with gain; but as they are easily fatigued, the line has to be very carefully drawn.

Very little can be done operatively in the reconstruction of these joints. The hands, however, offer a huge field for more reconstructive surgery, as the hands usually are badly deformed and cause much incapacity for ordinary pursuits, oftentimes the only usable parts of the patient, if the case is a severe one. With the better physiology, weight is gained, the nutrition of the skin first; the nails, hair, and muscles improve, and the bones, although they never apparently repair the destruction wrought, become denser as time goes on. It is interesting to note that as general health returns, the menstrual period becomes less and less a time of setback.

In the hypertrophic case the treatment is directed toward whipping up the retarded metabolism through exercise and activity. The diet is bulky, not too nutritious; laxative food such as vegetables, greens, stewed fruits are given, and plenty of water. Regular catharsis is indicated, as the bowel function is constantly sluggish. We have found that sodium phosphate is very effective, not only as a cathartic, but as a mild diuretic. The coated tongue, so frequently found in these hypertrophic cases, cleans up under its use.

Body mechanics again comes into play because of the acquired visceroptosis present in these long intestined, heavy viscera people. As they become less and less active physically the abdominal tone is lost and visceral sag results, causing more sluggishness of the bowels. This has to be corrected by supports and exercises until the abdominal muscles have regained their strength and tone, and the posture has been restored to a better point for relief of strain. As is so often the case, the arthritis is located in the knees and lumbar spine of the hypertrophic cases. One is called on to relieve all strain to these regions, and here probably is the chief reason for correction of body mechanics and the use of supports, foot plates, etc., in the hypertrophic case. Some of these cases have shown a low basal metabolism, and results of surprising quickness have been obtained in a few cases by the use of thyroid and ovarian extracts when combined with the foregoing outlined treatment.

Conclusions:

1. There are three distinct types of arthritis: infectious, atrophic, and hypertrophic.

2. These types differ etiologically, pathologically, and clinically, and in x-rays.

3. They respond to treatment differently and should, therefore, be differentiated.

4. Clinical data seem valueless unless these types are studied as separate pathological entities.

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THE OPERATIVE TREATMENT OF SCOLIOSIS.

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For more than a decade orthopædic surgeons have been studying the subject of scoliosis with particular interest. This study was interrupted by the Great War, but it has been resumed again in another form and promises to continue to be one of the subjects which will interest those engaged in the treatment of lesions of the bones and joints.

The work of Abbott, of Portland, in June, 1911, was perhaps the greatest stimulus to this study, although the work of Feiss,* of Cleveland, on the physiology and mechanics of the spinal column, which preceded the work of Abbott, should never be forgotten.

In June, 1911, the writer drew the attention of the members of the Canadian Medical Association to the fact that rotation of the thorax in one direction caused rotation of the vertebrae in the opposite direction. This seemed to be a paradox. The writer does not know whether it ever had been described before.

It was suggested that these physiological principles could be made use of in the treatment of pathological scoliosis. During the years 1911 to 1914, inclusive, Dr. Z. B. Adams of Boston and the writer, in Montreal, endeavored to evolve a rational scheme for the treatment of scoliosis by the production of physiological scoliosis of a reverse character to that of a pathological scoliosis already existing.

In 1914, before the Great War, the writer addressed the American Orthopedic Association, saying that practical experience had proved that because pathological scoliosis was a more advanced process than physiological scoliosis, it was useless to attempt to cure pathological scoliosis by superimposing physiological scoliosis of a reverse order upon the pathological scoliosis already existing, because the lesser could not be depended upon to cure the greater.

At this meeting the writer expressed his conviction that no effective form of treatment had been found for pathological scoliosis where bony changes had occurred. Posture, pressure, exercises—all had failed and would continue to fail. The hope of the future seemed to lie in operative procedures.

For some years the Medical Staff of the Children's Memorial Hospital in Montreal had been preaching that few cases of extreme scoliosis attain old age. Many died from circulatory disturbances due to obstruction caused by thoracic deformities.

In 1915 the Committee which had been appointed by the American Orthopedic Association to report on the treatment of structural scoliosis reported unfavorably on the progress made by patients treated in Boston by the method which had been practised by Dr. Adams, of Boston, and the writer. This statement caused no surprise, because, a year before, the attention of the American Orthopedic Association had been drawn by the writer to the fact that pathological scoliosis could not be cured by superimposing physiological scoliosis on it. The less could not cure the greater. Something more is necessary.

An examination of the Report of the Scoliosis Committee of 1915 showed the following words:

"Of the six cases thirteen to seventeen years of age which have been treated by the rotation treatment—they were all in fairly good condition, but in two cases collapse seemed imminent after the jacket had been removed and the patient kept standing for inspection. Not only had over-correction not been secured in any case, but in none was there marked diminution of any of the elements of the deformity. . . . The Committee feels justified in considering the results as distinctly discouraging."

The Committee was justified in feeling discouraged if it were looking for cure or even marked improvement, because this treatment had been condemned by its sponsor a year before.

The Committee's report was a valuable contribution because it drew attention to the fact that two cases out of six had shown signs of collapse when, by the removal of the jacket, they had been permitted to relapse into a position of pathological scoliosis. There had been no collapse when placing them in a position of physiological scoliosis.

It is important to bear in mind that the deformity of scoliosis, as seen by the surgeon, is simply an outward and visible sign of a very much more marked deformity which obtains in the interior of this region.

Theory and experiment have likewise proved the importance of increasing the capacity of the thorax in cases of scoliosis, in order that the thoracic organs may be in the best possible position to function.

This can be done best by placing the patient in a position of physiological scoliosis, the reverse of the pathological scoliosis from which the patient suffers.

From our point of view the key to treatment was the discovery of the physiological fact that rotation of the trunk in one direction or side-bending of the trunk in one direction causes rotation of the vertebrae in another direction.

We have felt, then, that in cases of scoliosis, be they mild or be they severe, treatment must be based on the necessity of placing the vital organs, as well as the thoracic walls, in a position of the greatest possible correction.

We had, as early as the end of 1913 and the beginning of 1914, decided that there are a large number of cases of scoliosis which do not respond to any known method of treatment. Further, we had agreed that the hope of the future seemed to lie in operative procedures. The next step was to search for an operation which would be a rational procedure from the point of view of the etiology of the condition.

All of us realize that scoliosis may be due to a great many different causes. For the purpose of this paper let us consider three of these: (1) An unstable base to the spine; (2) A loss of stays; (3) Congenital malformations.

1. *An Unstable Base.* Dr. Adams claims that in the majority of cases of scoliosis the deformities are due to irregularities of the last lumbar vertebra, causing an unstable base for the superimposed segments of the vertebral column. Undoubtedly this statement is true in a goodly number of patients afflicted with this condition.

Here the operative procedure must aim at the creation of a stable base for the superimposed vertebral column. Here the body of the fifth lumbar vertebra seems to be primarily at fault. Here the body must be so repaired or its position so changed that it will be made to afford a sufficient pedestal for the vertebral column.

2. *A Loss of Stays.* Our Montreal experience demonstrates that in a large number of the severe cases of scoliosis the etiological factor will be found to be an irremediable weakness of muscle due, for instance, to such form of paralysis as that due to poliomyelitis. Here operative procedures must aim at stabilizing the spinal column.

3. *Congenital Malformations.* English observers claim that, in a certain number of patients suffering from scoliosis, congenitally wedge-shaped vertebrae will be found to be the cause.

SUITABLE CASES FOR OPERATION.

1. Only such cases as are becoming progressively worse are suitable for operative procedures.

2. Those cases in which temporary improvement can be obtained by non-operative procedures are suitable for operation. Each case is subjected to a careful examination before operative procedures are considered. It must be possible by traction on the spine or by traction combined with rotation or side-bending to secure considerable correction before operative procedures can be, with fairness, considered. The patient's general condition must be good enough for him, or her, to stand a severe operation.

OPERATIONS.

It has been seen, then, that two forms of operation are indicated,—first, the operation which should be decided to meet the theory that the cause of scoliosis is a lack of stability of the base of the spine due to an unequal development of the lateral segments of the fifth lumbar vertebra, and, second, an operation to stabilize a vertebral column, which lacks support of muscle or ligament following a paralysis.

1. *Operations on the Fifth Lumbar Vertebra.* I do not know of any operative procedure which has been devised for the correction of the architecture of the fifth lumbar vertebra. Dr. Adams of Boston has always insisted on the importance of making this discovery, and, I understand, has made many experiments along this line. Personally, I am convinced that in those cases in which the etiological cause of scoliosis lies in lack of development of the fifth lumbar vertebra, the anterior surface of the bone of this vertebra must be approached through the anterior abdominal wall, while the patient is in the Trendelenberg position. The promontory should be exposed, and a portion of the disc between the fifth lumbar and the sacrum removed, in order that it may be replaced by a wedge-shaped bone graft which, it is hoped, will assure a stable base for the vertebral column. Although this operation has never been practised, and although it would seem to be a very severe one, my experiments with the cadaver have led me to believe that it would be possible, and, in cases where scoliosis was potentially severe enough to justify its performance, it might be considered. Further than this I cannot go.

2. *Operations for the Stabilization of the Spine.* There are at least three operations for the stabilization of the spine.

(a) Albee's operation. Those who consider bone grafts as suggested by the pioneer Albee as an efficient means for the stabilization of a number of vertebrae employ the Albee operation.

(b) Hibbs' operation. Those who prefer the mechanical perfections of Hibbs' operation employ that procedure for the stabilization of the spine.

(c) Other operations. In Montreal, we have felt that neither the Albee nor the Hibbs operation is suitable for the stabilization of large numbers of consecutive and adjacent vertebrae. We have devised, then, an operation for the treatment of such conditions. This was described in the September, 1920, number of the *Journal of Orthopaedic Surgery.*

GENERAL CONSIDERATION.

Operations must be undertaken only after sufficient consideration. In many cases the deformity is already arrested; thus attempts to arrest are not indicated. The possibility of success may be shown by the amount of correction which is possible by forcible extension and rotation. We must not perform an operation for the fusion of vertebrae unless we are sure that the procedure chosen will really produce a fusion which will not fail when subjected to stress and strain, which stress and strain, of course, is directly proportional to the number of vertebrae fused.

We must not submit a patient, whose vital organs are working at disadvantage through thoracic deformities, to a lengthy and shock-producing operation if shock can be minimized by operating in two stages.

If it is considered advisable to fuse both the dorsal and lumbar vertebrae it is, perhaps, wisest to fuse these two regions at two different times. It is our custom in Montreal to operate on either the dorsal or lumbar vertebrae at one time, to secure the greatest amount of correction possible and to maintain this by the use of a plaster jacket for six months. At the end of that time, a second jacket may be applied and the same treatment may be carried out.

In considering the question of operative procedures indicated for the relief of scoliosis the etiological factor responsible for the specific case under consideration is of prime importance.

AFTER-TREATMENT OF OPERATIONS FOR SPINAL FIXATION.

Immediately the operation has been performed the patient is, by traction and rotation, placed in a position of the greatest possible correction. A plaster jacket is then applied while the patient is still under the anaesthetic. This procedure is, undoubtedly, the best, although it is not practicable in some cases where the patient's general condition will not permit of the application of the plaster jacket under anaesthesia. In these cases the plaster jacket can be applied some days or weeks later. These latter do not, however, suffer that minimum amount of discomfort and lack of pain seen in those who are placed in immobilization while still under an anaesthetic. They are maintained in such plaster for six months, and during half of this time they are kept in recumbency.

RESULT OF TREATMENT.

While I consider this procedure to be a very severe one, I am happy to be able to report that no patient has died during or immediately following the operation. On the other hand, one patient in ten who have been operated upon died of pneumonia two days after operation, and, while we feel sure that this pneumonia was due to the operation, death can hardly be considered as being caused by this particular procedure. Every patient has claimed improvement in her general condition after operation. The patient's height has been greater after the procedure, although I cannot be sure that the increased height which was originally seen, and which it had seemed possible to attain before the operation by extension and rotation or extension and side-bending, has been maintained. We have endeavored to prove by X-rays that bony union occurs, but because of the position of the operation on the bone, hidden as it is by the bodies of the vertebrae, we have been unable to do so, although we have, on several occasions, when doing our secondary operation, been able to demonstrate a broad ribbon of bone extending from vertebra to vertebra on the posterior surface of the angles of the vertebrae. This ribbon of bone, which covered the posterior surface of the angles, seemed to us to be of sufficient strength to maintain the correction secured.

CONCLUSION.

We feel that, although operative procedures for scoliosis cannot be considered to have stood the test of time, they have been sufficiently encouraging to permit us to continue their employment. We have never operated for cosmetic effects and we have purposely operated only in a limited number of patients under the conditions already mentioned. We hope that the day will come when the field of usefulness of operative procedures may be extended, but we would hesitate to recommend their general use, because, as we have already stated, the operation is a severe one. It should not be carried out except after deep thought and consideration, and then only by those who are accustomed to operate on the spine. Perhaps at a later date its field of usefulness will be broadened, but until we have been able to prove the enduring character of the ankylosis and the general benefit to the patient, as shown by increased height and marked improvement in general condition, we have no right to employ it except in desperate cases.

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FURTHER OBSERVATIONS ON INTRA-PERINEURAL NEUROTOMY IN SPASTIC CONDITIONS.

BY JOHN JOSEPH NUTT, M.D., NEW YORK.

In June, 1909, at the meeting of the American Orthopedic Association held at Hartford, I reported two cases of intra-perineural neurotomy, one of which I presented. Since then I have performed the operation 27 times, and it would seem proper to make a further report upon its usefulness.

The operation has no effect upon the pathological condition. It is in no sense a cure. It is purely symptomatic treatment, and the best to be expected from it is an alleviation of the incapacity caused by the original injury or disease.

The names generally used for the condition under discussion are: cerebral spastic paralysis, infantile spastic paralysis, hemiplegia, spastic paraplegia, and Little's disease. Although it was recognized as an entity by Nicholas Andry in 1741, it was first scientifically described by Little in lectures in 1843, and published in volume form in 1853. Fifty-two cases were reported by him in detail in a paper read before the Obstetrical Society of London in 1862.

Definition. A condition of spasticity of skeletal muscles due to loss of cerebral control and accompanied by varied phenomena due to nervous lesions. The mentality is usually affected. It is usually congenital or follows one of the exanthemata. The lesions are incurable, but the disability can be markedly ameliorated.

There are those who limit Little's disease to cases in which the pyramidal tract is involved, while others include cases showing the characteristic symptoms but not depending at all upon traumatism at birth.

Pathology. Thrombus of the superior longitudinal sinus and rupture of cerebral veins, caused by overlapping of the parietal bones during a difficult labor, is usually the predominant factor in causing this disease in congenital cases. This hemorrhage may be either subdural or intermeningeal. It may be quite general or limited to one

hemisphere. There are contributing conditions of inheritance which sometimes seem to be of importance.

The pathology has been described by Little, McNutt, Freud, Gowers, and Kundrat. As a result of the hemorrhage, certain cells of the cortex suffer edema and degeneration. Mr. E. Muirhead Little stated in 1907: "despite all the researches that have been so far made, it is impossible in the present state of our knowledge to predicate from the clinical features of a case what is the anatomical lesion causing it, and the converse also holds good; therefore, at present the pathology of infantile spastic paralysis has only an academic interest for the practical surgeon, whether he has to deal with the congenital or the acquired varieties of the disease."

The lower neuron is histologically normal. The muscles involved are held in tonic contraction, which is absent during sleep and narcosis. After a period the fibrous tissue in the muscles becomes shortened so that contractures exist.

Prognosis. There can be no restoration of lost nerve tissue, Any improvement depends upon the strengthening of cells weakened, but not destroyed. In that sense there can be no cure.

I would advise optimism in every case that is not of too low a mental grade. The undoubtedly idiotic and low-grade moron I do not consider should be given the time and attention which is so essential in all of these cases.

The majority of these patients can be made to walk with braces. Some may be able to discard braces, while others will need crutches as well, but improvement may be promised in every case. The satisfaction of reclaiming a patient condemned to a bedridden life so that he may be able to take his place in the usual activities of life with comparatively few restrictions, amply repays one for all the time and trouble.

Treatment. The only prophylactic measures possible are skillful obstetrics and means of controlling the hemorrhage as by increasing the blood coagulability.

Dr. W. J. Little and his contemporaries practised tenotomies, immobilization, and exercises. Today there are few who tenotomize any except the permanent contracted tissues. Simple tenotomy has been extended to, in some instances, resection of muscles and fasciae and tendon lengthening. It was early noticed that tenotomy for a single muscle did not limit its beneficial effects to that muscle: the spasm of other muscles would be diminished, and furthermore, other symptoms, such as general

nervousness and excitability would be favorably affected. It was the fact that improvement following tenotomies was not limited to the muscles operated on that led me to consider the advisability of putting a number of muscles out of commission for a protracted period. A more widespread benefit than from a tenotomy could thus be enjoyed, and the delay of waiting for contractures avoided.

Tendon transplantation has been practised for a number of years, more frequently with the biceps femoris than any other muscle. The majority of surgeons, however, feel that there is little to be gained by this operation over what is gained by tenotomy. The transplanted spastic muscle is not needed to reinforce a healthy muscle.

Arthrodesis, especially at the ankle, is a very satisfactory operation, as it gives a firm support to the leg, and is preferable to permanent deformities of the foot.

Förster devised the operation of radicotomy, which was performed by Tietze. It has been modified by Van Gehuchten. The operation has a mortality of 7 per cent. to 15 per cent., and is a tedious and an exacting one.

Allison and Schwab have paralyzed peripheral nerves by the injection of alcohol. This blocking of the nerves lasts for about three months.

Sharp, in cases which show intra-cranial pressure, performs the operation of decompression. He finds one out of three or four cases suitable for this operation, and has performed it several hundred times.

Stoffel resects a portion of some or all of the motor nerves to the muscle. The "nervous rest" is not widespread and is permanent. I frequently resect parts of individual nerves when it seems desirable in conjunction with intra-perineural neurotomy.

We shall confine ourselves to considering only cases in which spasm is the chief cause of the loss of function. The spasm may be limited to a few muscles, and yet, in consequence, standing and walking be practically impossible and render the patient incapable of mingling with other children. In such a case resection of part or all of the nerves to the muscles with, perhaps, myomectomy may be sufficient. In some cases the spasm may be sufficient to incapacitate the child and yet be susceptible by passive stretching and braces to an almost complete cure without any operative interference. After contractures are established, free movement of the joints must be restored before any other treatment is undertaken. Therefore, after eliminating cases of very low mentality, cases of pure contractures and cases of slight spasticity, we

have left a class in which, we believe, this operation should be considered.

Intraperineural neurotomy should not be performed except in cases that can be under the care of the surgeon for several years; otherwise the great expectations which may have been raised in the minds of the parents can result only in disappointment.

The Technique of the Operation. I have operated upon the sciatic, the popliteals, the posterior tibials, the obturator, and the anterior interosseus. In the larger nerves it is comparatively easy to suture the severed ends, while in the smaller nerves, as in the anterior interosseus, it is a difficult undertaking. After exposing the nerve, the neurilemma is divided by a longitudinal incision and the nerve itself lifted out. Two or three anchor sutures are placed above and below the site of the proposed neurotomy. The nerve is divided with a sharp knife, and the anchor sutures tied. The chief object of these anchors is to prevent rotation. With the nerve relaxed there is very little danger of separation at the ends. The sheath is then sutured and the part put up in plaster of Paris.

In most of the cases there is considerable pain for several days, which may demand the administration of an opiate. The time necessary for the nerves to grow to their nerve endings varies naturally with the distance. Cutting the sciatic paralyzes the muscles of the leg for about ten months. It is practically impossible to report cases in such a way as to be of any real value. They would be simply a series of cases in which the incapacities of the patient were described in detail, the date of the operation and the subsequent examinations. It would make a tedious report and confirm but little. Photographs might help, but the only ones of real value would be moving pictures. A moving picture of a child attempting to stand before the operation and the same child at intervals later on would be excellent, and I regret I have no such pictures to offer.

Our work has taught us some facts which, although trite, may be worth while calling or recalling to your attention. The patient's co-operation is a *sine qua non.* The personality of the nurse is of the greatest importance. All atmosphere of the patient being "queer," a "sight," a "curse," or a "nuisance," should be removed and replaced by an environment conducive to happiness, expectation, determination, and affection. Discouragement must be avoided at all times. The treatments must be carried out conscientiously, punctually; and if a nurse

cannot be had, a member of the family, or someone else, will have to give the time necessary.

At first, passive movements alone are used. In every untreated case some gain will be made within a few weeks. All the contractions are stretched, slowly, but firmly, with very little pain. The séance need last but a minute or two, as the attempt is not repeated more than twice or thrice at any one time. Each joint is systematically gone over. These exercises should be done three times or more a day. When all is gained which can be gained by this method, the remaining deformities are to be relieved by operation. Stretching under an anaesthetic is then performed, and tenotomies only of true contractures. If the calf muscles are in strong spasm together with the hamstrings and the adductors, intra-perineural neurotomy of the sciatic just below the gluteal fold with resection of the nerve to the semi-membranosus and adductor magnus, which usually branches off above this point, or the external popliteal division of the sciatic may be left intact, and its branch to the short head of the biceps resected. All the joints are forced through their usual range of motion, the patient is then encased in plaster of Paris from the toes to the axillae, with the hip abducted and externally rotated, the knee extended, and feet placed at a right angle to the leg.

Improvement may be noticed immediately in the general physical and mental condition, and after six weeks braces with a pelvic band, lock joints at the knees, and right-angle stops at the ankles, are applied. The patient is now encouraged to stand and to walk. These attempts are made at regular designated hours. As soon as possible the child is taught some occupation, if she has not one already, such as sewing, crocheting, drawing, etc. It may be possible to discard the pelvic band within six months, but the leg braces must be worn for several months after the restoration of the sciatic function. Three years of conscientious treatment with the assistance of a nurse, if possible, and of a member of the family, if not, should be counted on.

I will conclude with a description of one case. A girl, twelve years of age; history of congenital spastic paraplegia. Had stood up beside the bed, and by holding on to the chairs had taken a few steps. Never walked even with crutches. The family in very moderate circumstances, and the child allowed to remain in bed all the time, except when sitting in a chair. Had absolutely no contact with the outside world except through the family and a few intimate friends.

Upon admission to the hospital she was very well developed physically, but the mental development by Binet's test was of about five years of age; of a surly disposition, holding head down with eyes downcast, and seldom raising the head when spoken to; raising the eyes, but with no movement of the head. No contractures existed which could not be overcome under anaesthesia. Intra-perineural neurotomy performed on both sciatics, high up so as to include the hamstring muscles. The routine treatment as roughly outlined above was carried out.

Three years later the patient walked with crutches, but without braces. Some return of the spasm of the feet remains to be overcome. Patient attends school. Although still backward in her studies, she is not at all feeble-minded. She has a cheerful disposition, smiles readily, and her surly expression has changed to one of happiness and contentment.

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UNUSUAL FRACTURES.

Case Reports from the Orthopaedic Clinic of the Massachusetts General Hospital.

BY C. W. PEABODY, A.B., M.D., BOSTON, MASS.

A REVIEW of the acute fracture cases treated on the Orthopaedic Division of the Massachusetts General Hospital for the twelve months, beginning July 1, 1921, reveals three of sufficiently unusual nature to seem to warrant special report. The first of these presented the "cart-wheel fracture" of the textbooks, in which the leg is caught in a revolving wheel, the resulting torsion completely disrupting the lower end of the femur from the shaft at the epiphyseal line. Our patient was not caught in a cart-wheel, but knocked down by a motor-car, and in addition the break had the complication of being compound from the protrusion of the shaft through an external wound. Therefore, his very fortunate outcome seems quite striking. The second case is a fracture of the spine at a most uncommon point, and producing a skiagraphic impression which is rather startling. The neural arches of the first lumbar vertebra were fractured between the superior and inferior articular processes, the fragments separating as the spine hinged in flexion on the disc in front; so that the first glance at the x-ray gave the impression of a complete loss of bony continuity in the spinal column. The last patient, thrown from his horse, was caught under the falling animal, with a consequent rupture and complete dislocation of the pubic synchondrosis; the two halves of the pelvis, rotating in opposite directions, at the sacro-iliac articulations, produced a fracture of both transverse processes of the fifth lumbar vertebra. Perhaps the most remarkable fact in connection with this last case is his recovery without any internal complications. The three case reports follow:

CASE I. Richard B., white, aged 11. No. 237762. This patient was knocked down by a passing automobile and the left knee was injured. Received on the Service for treatment about five hours after the accident. Examination showed the leg an inch short and with normal knee contour replaced by an irregular deformity. There was a small lacerated

FIG. 1.—Case I. Lateral view of extended knee after consolidation. Note abundant callus anteriorly where periosteum had been raised from shaft.

wound in front of the biceps tendon, oozing freely, but when sponged revealing bare bone. X-ray plates taken at that time showed complete separation of the lower femoral epiphysis, which was displaced upward on the front, and a little to the inner side of the end of the shaft with the condyles looking forward. (These plates were subsequently much in demand and, unfortunately, destroyed at a demonstration.)

In view of the compound condition, surgical intervention seemed indicated, and was undertaken by Dr. P. D. Wilson, the writer having the privilege of assisting him therein. With the patient in the prone position the wound on the lateral aspect was explored and a débridement performed. The excision revealed the lower end of the femoral diaphysis lying subcutaneously, stripped bare of periosteum and grimy. The line of fracture was not at all jagged, and though irregular, was

FIG. 2.—Case I. A. P. of knee after union.

quite smooth and evidently represented the epiphyseal line. The epiphysis itself was displaced mesially and not seen, but seemed intact to palpation. No communication with joint space was found, the capsular attachments evidently remaining untorn around the epiphysis. The bone end was carefully sponged clean and the wound cavity wiped free of all blood and débris, no antiseptic being used. Manipulation for reduction was done before closing the wound. The first manoeuvre was traction in extension by one operator, and while still maintained, rapid flexion of the leg to 90 degrees by the other. This resulted in partial replacement, the condylar fragment still projecting a little anteriorly, but as soon as traction was relaxed it relapsed into the previous position. The

Fig. 3.—Case I.

Fig. 4.—Case I.

Fig. 3 and Fig. 4.—Case I. Taken ten months after injury. The amount of knee valgus is in fact slightly greater on affected side.

second attempt was by a similar manoeuvre, but as soon as flexion of the leg was undertaken, heavy downward pressure was made over the popliteal space, counter thrust being obtained from a folded sheet between the table and the patella. This combination was entirely successful, the epiphysis being driven back over the end of the shaft with a snap, and remaining firmly in position despite free motion of the knee. Palpation in the wound then corroborated the exactness of the reposition, and the wound was closed in layers without drainage. A plaster cast spica was applied with the knee maintained in 90 degrees flexion.

Patient showed but slight shock as a result of the procedures and convalescence was uncomplicated and afebrile, the wound healing by first intention. At end of three weeks cast was removed and limb placed in a Thomas splint, a second piece attached by hinges at the level of the knee, carrying the lower leg and allowing protected motion, at first passive, later active, but always voluntary. In a little over two weeks complete active extension was possible, and six weeks after injury the patient became ambulatory in a plaster cylinder cast and

was discharged from the hospital. Two weeks later the patient discarded the cast and began walking with crutches. Examined in the Out-Patient Department at the end of two months was found to have full normal function with the exception of 10 degrees limitation of complete extension. At that time he was shown exercises to overcome this. He was not seen again until visited by the writer, 10 months after the injury, when the accompanying snapshots were made. Both legs showed some knock-knee, and this was a little more pronounced on the injured side; both showed the same normal hyperextension and equal motion in flexion. There was no shortening on the injured side or any laxity of the knee joint.

CASE II. Victor C., white, aged 10. No. 239432. This boy was transferred to the fracture service a few days after being admitted to the hospital with a fractured skull, dislocated elbow, and a fracture of the spine. The head injury had not proved serious, the dislocation had been reduced, but the injury of the spine was of such a peculiar character and so startlingly suggestive in its x-ray appearances of a serious weakness in structure, that a question arose as to the necessity for internal fixation. Spinal injury had been indicated on admission from the presence of crepitation and abnormal mobility over the spine of the second lumbar vertebra, and subsequent x-ray examination showed that a fracture had occurred on both sides at the junction of the neural arches and the laminae, so that one of the fragments consisted of the body, neural arches and superior articular processes, and the other of the inferior articulation, laminae and spinous process. A consequent slight separation thus brought about a complete loss of bony continuity in the spinal column.

On consultation it was agreed in this case that as the views showed no evidence of rotation or lateral dislocation, placing the spine in sufficient hyperextension should bring reapproximation of fragments, and stable union should occur from callus formation as normally in bony tissue.

The patient was treated by placing him prone in spinal hyperextension, moulding a plaster bed to his back in this position, and keeping him recumbent, supine in this shell for six weeks. A plaster jacket cast was then applied in this same attitude, and the boy went home ambulatory and free from symptoms. He returned to the O. P. D. a month later to progress into a brace, but an x-ray taken then for control showed a defect still present, and no shadow of callus formation. The jacket was accordingly continued for another month, at the end of which

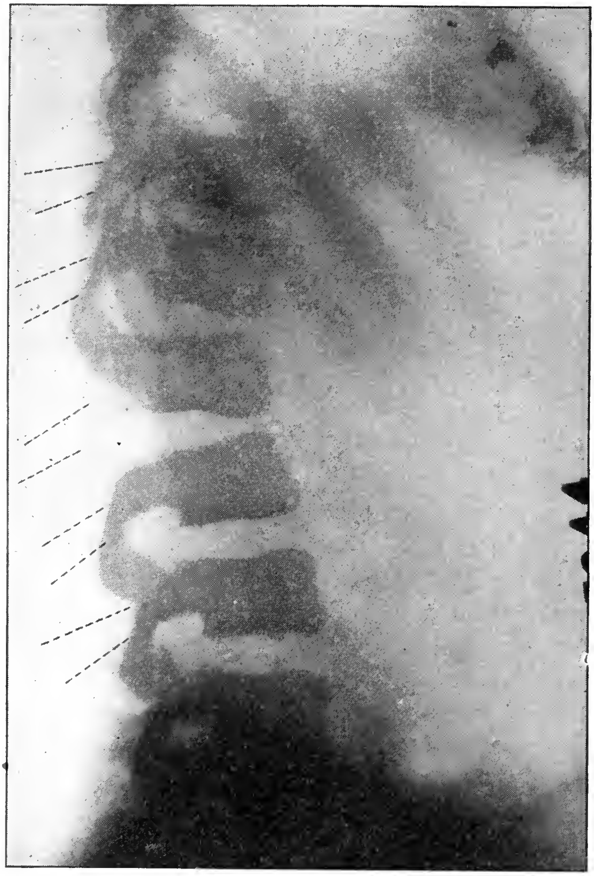

Fig. 5.—Case II. Injury to 2nd lumbar vertebra. Fracture has occurred through both neural arches at junction of superior and inferior articular processes, the latter with the laminae and spinous process forming the lesser fragment. At the age of this patient the posterior part of the spine is not sufficiently calcified to show on the x-ray plate.

time x-ray examination showed gap closed and definite callus formation. Six months after injury no clinical evidence of injury could be found.

Case III. Thos. W., white, aged 34, riding-master. No. 240464. This patient was injured about an hour before entry while training an unruly mount in the ring. The horse reared and went over backward, and the rider, throwing himself clear, landed, however, in a corner where he was caught by the animal rolling upon him. The man kept his head and legs out of the way, but the weight of the horse was received

FIG. 6.—Case III. Pubic dislocation, projected as if seen from behind.

for a second on his lower torso. At this instant he experienced a severe pain at the lower part of his back. He then rolled free and attempted to rise, but was prevented by great pain in the front of the pelvis and at the same time a deep grating sensation, described by him as similar to what he had many times felt in a horse with a broken leg. A doctor present gave him a quarter of morphia, put a swathe around his pelvis, placed him on a stretcher and sent him in to the hospital. Examination in the accident room showed a rugged man with dusky or ashen face and anxious expression, sweating profusely and with a general clamor. Lay on right side with knees drawn up, protesting against being moved and especially against separation of knees. Very tender over lumbar area and over sacro-iliac region both sides. Careful passive motions of hips possible in moderate range. Compression of iliac crests elicited no symptoms. Forward pressure behind left great trochanter caused deep heavy crepitus and pain not definitely localized. Same from pressure under tuberosity of left ischium. There was no spasm or rigidity of abdominal muscles and no bleeding from

urethra. Could not urinate but stated that he had emptied bladder just before mounting. Patient was sent to x-ray with diagnosis of fracture of both rami of left pubic bone. The resultant plates failed to show such lesion but revealed complete dislocation of the pubic synchondrosis, the left side being below the right, and also fractures of the transverse processes of the fifth lumbar vertebra.

The outstanding feature of the immediate course of this patient was the very slow recovery from shock. He was always conscious, rational and collected, but for several days experienced what he described as a sensation of impending dissolution. His body remained cold and clammy, with frequent general fine tremors entirely uncontrollable. Stimulative treatment had little effect save to increase insomnia and for a week sleep was possible only with maximum depressants. Did not void spontaneously till fourth day, but urine at no time contained blood. Reduction of the dislocation was sought by suspending the pelvis in a canvas hammock having a fixed support on one side and weight sufficient to elevate one buttock on the other. Palpation indicated some improvement in the deformity felt at the symphysis, but not complete reduction. The patient's condition made manipulation seem unwise for the time being. At the end of a week a general anesthetic was given, the pelvis manipulated guardedly until the relation of the bones felt normal, and a double plaster spica applied. X-ray examination made through the cast was too indistinct to furnish accurate evidence of the completeness of the reduction, but the patient was made quite comfortable. He was kept on a frame in bed for six weeks, when a low plaster jacket was substituted for the double spica and he was allowed up for a few minutes daily on crutches. In two weeks he was able to navigate very well and left the hospital ambulatory, wishing to continue treatment at the office of a member of the staff. We neglected to obtain a final x-ray, but the surgeon to whom he went reports a subsequent examination showing normal relation of parts. The plaster jacket was soon exchanged for a supportive corset and the man went back to work. Four months after injury he was riding again and testified to no incapacity or disability that he could notice.

Certain points may be presented for discussion in these three cases. A hasty consideration of the factors involved in all easily leads to the thought of operative fixation. The advantage of internal fixation in many forms of bone and joint lesions is becoming increasingly recognized, but to many it also seems that the possibility of successful

results from external measures in the great majority of cases is not sufficiently kept in mind.

It is our opinion that reduction in the first case could have been just as easily and as accurately secured if the necessity for débridement and exploration had not been present. Once accurately secured, maintenance of the epiphyseal fragment in apposition was attended by no difficulty beyond the careful application of a plaster dressing, and the shift to a double Thomas splint allowed motion without danger at a stage early enough to preclude adhesions. In connection with this point it should be mentioned that Cutler reported a similar injury, not compound, which was successfully treated by external measures.[1]

In Case II a proper argument arose as to whether consolidation could be surely expected and the danger of a weak spine, with subsequent deformity, be dismissed unless a bone graft were placed across the involved area. A careful study of the x-ray picture and the mechanics involved indicated, however, that the danger was more apparent than real. At this point in the spine, which normally shows a lordosis, the weight is carried only partially on the vertebral bodies, and on account of the center of gravity of the overlying trunk being posterior to them, there is also a considerable downward thrust against the pedicles through their articular processes. So the fragments in this case would not tend to separate in the erect position as the x-ray suggests, but would be forced together. But a mistake was made in the treatment which probably delayed the reapproximation and final union. Hyperextension would, of course, tend to bring the fragments in apposition. It was accomplished in the supine position on a plaster bed. This meant that a thrust was made upward or anteriorly over the spinous processes of the involved segment. The direction of these processes being oblique to the surface, the first effect of pressure on them would be changed into leverage with the two affected facets offering the fulcrum and the articular processes at the point of fracture tilting backward and away from each other, instead of together. Further backward flexion of the spine, of course, brought some approximation, but in less perfect alignment. A little study of the exposed vertebrae in a skeleton was required to make this clear to us. Obviously the hyperextension would have been maintained better on a shell in the prone position and the bad effect described avoided.

Case III was interesting for one reason in the analysis of the cause of the fractures of the transverse processes of the last lumbar vertebra. The examination of the patient and review of the circumstances attend-

ing his injury made it seem improbable that any direct violence could have been applied at these points. It did seem possible that with the abnormal motion of ilium on sacrum permitted by the pubic rupture, indirect violence might have been transmitted through the stout ligamentous bands between the tips of these processes and the crests of the ilia. It will be noticed in the x-ray that the line of fracture in each is well out toward the tip. Another point arises from the fact that the amount of separation of the two pubic bones would seem to indicate a complete rupture of the ligaments between them, with the suggestion that even if reduction were secured, the resultant union would be unstable and some sort of operation such as wiring indicated. By just what method nature effects a sufficiently strong consolidation here we are unable to say, and complete reduction was not secured for some time after injury. But the fact that at this writing the patient for two months has been able to train spirited hunters is sufficient evidence that nature has done the job as effectively as could the surgeon with drill and wire.

REFERENCE

[1] Cutler, E. C.: "Notes on the Non-Operative Treatment of Fractures," Annals of Surgery, 1921, Vol. lxxiii, No. 1, p. 91.

"FLAT HAND" (MANUS PLANUS): ITS CORRECTION ESSENTIAL TO NORMAL FUNCTION OF HAND.

BY JOEL E. GOLDTHWAIT, M.D., BOSTON, MASS.

At the meeting of the American Orthopedic Association held in Washington in 1913, a paper was read by the writer upon "The Carpal Arch: The Importance of Its Development in the Function of the Hand."

This paper was published in the *Zeitschrift f. orthopädische Chirurgie* at the request of the Publication Committee of the American Association, which was at that time endeavoring to arrange an exchange of scientific contributions between the orthopædic groups at home and abroad. Probably because of the limited reading of the *Zeitschrift*, very few even of the members of our Association know of this article, and since this structure does not seem to be recognized in the treatment of the common injuries or diseases of the hand so that unnecessary crippling results, the article has been rewritten, with such additions as have naturally resulted from the experience since the original article was prepared.

The war casualties have served, probably as nothing else could, to emphasize the importance of preserving functional elements which under civil conditions would receive little attention, and in the hand especially, where very slight degrees represent the difference between a useful or useless member, it becomes extremely important that the mechanics of the function of the hand be thoroughly understood. Limited motion in the carpal joints may cause little disability, but the faulty adjustment of the bones may cause great disability. A flat carpal arch which cannot be corrected by the contraction of the muscles makes impossible the normal grip of the hand, as well as the approximation of the thumb to the fingers, which naturally prevents all delicate use of the hands.

To fully understand the mechanism of the function of the hand, it is necessary to refer to the anatomy, which shows that the hand is so formed that in repose the palmar surface is concave both longitudinally and laterally. (Figs. 1 and 2.) The bones of the carpus are arranged so that there is a well-marked arch transversely, this being more pro-

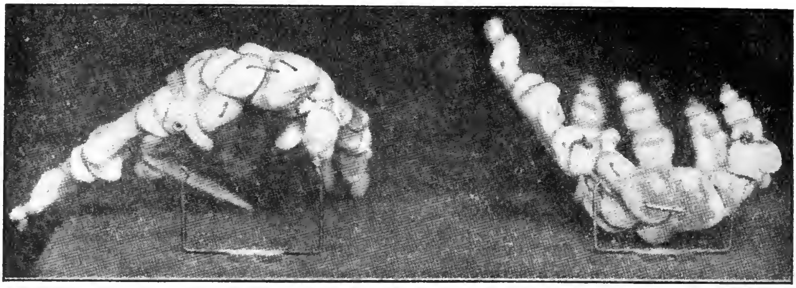

Fig. 1.

Fig. 2.

Fig. 2.

nounced in the second row than the first. The first row is not only arched transversely with the concavity toward the palm, but the bones are also arranged so that they form an arch, the concavity of which faces forward toward the fingers. Into this latter arch the proximal portions of the os magnum and unciform bones fit (Fig. 3), and the stability of the arch formed by the first row naturally depends considerably upon the position of these two bones which fill the concave portion. Not only is this true in regard to the stability of the first row, but the grasp of the first row upon the unciform and os magnum

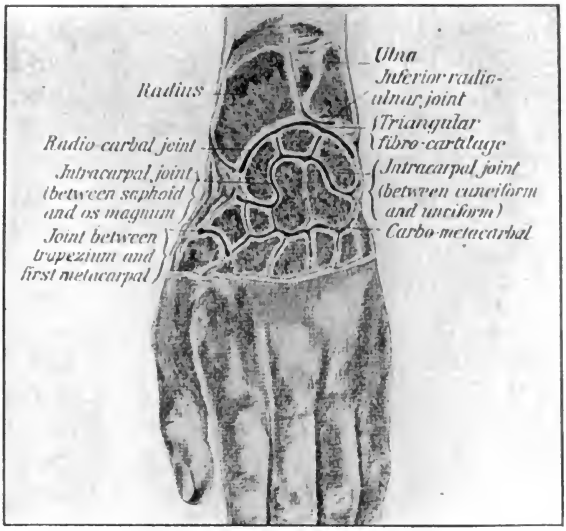

Fig. 3. (From Gray's Anatomy.)

serves to maintain to a very considerable degree the arch formed by the second row. The trapezium and trapezoid rest upon the distal end of the scaphoid (Figs. 2 and 3) and their distal surface is on a line with the distal surfaces of the os magnum and unciform. The trapezium is placed so that it projects much more into the palmar surface of the hand than do the other bones.

The distal surface of the second row of carpal bones is practically transverse (straight across) and against this rest the ends of the second, third, fourth, and fifth metacarpal bones. The first metacarpal is placed more anteriorly (Figs. 1 and 2), resting directly against the distal surface of the trapezium. In the articulation formed by the second, third, fourth, and fifth metacarpal bones with the carpus, there is comparatively little motion. In the articulation formed by the first metacarpal and the trapezium there is quite free motion, and the function of the hand depends to a very considerable extent upon the movements allowed at this joint. The surface of the trapezium at this articulation represents a section of a cone, and the movement of the base of the first metacarpal bone is a sliding one around this conical surface. This is clearly shown if the movement of the thumb is watched from the position of full extension to full adduction of the thumb on the hand, with the thumb itself kept straight. When the hand is in full

extension, if viewed from the palmar surface, the nail of the thumb is scarcely visible, while the palmar surface or ball of the thumb is almost wholly visible. With the adducted thumb, the palmar surface of the thumb, or the ball, is practically entirely hidden, while the nail is wholly visible. It is evident at once that this can be accomplished only by the movement of the base of the thumb, which is accomplished as the first metacarpal slides about on the conical surface of the trapezium.

Not only this, but the function of the fingers depends to a very considerable degree upon the arched structure of the carpus. When the fingers are fully extended with the arch preserved, they spread out in fan shape, following the direction of the metacarpals. When the fingers flex, however, they draw toward the median line. The middle finger flexes in the line of its metacarpal; the others flex toward the middle of the palm. The index finger draws toward the ulnar side and comes in contact with the tip of the middle finger; the ring and little fingers draw toward the radial side so that the ends of the fingers are in contact at the sides, while the tip of the thumb comes in contact with the tips of the other fingers, but facing in almost the opposite direction. This convergence of the finger tips to a common point is absolutely essential to the delicate use of the hands, and is impossible unless the carpal arch is preserved.

With the carpal arch obliterated, in flexion of the thumb it is impossible to touch the finger tips or to touch the palm of the hand. The fingers may flex, each upon its own metacarpal, but without inclining toward the median line, and consequently without coming in contact with the others. No delicate function is possible under such conditions.

The higher the arch the more will the little finger incline toward the median line in flexion, and the farther will it be possible to carry the thumb beyond the median line.

The maintenance of the position of the carpal bones depends, as is true in the arch of the foot, upon the muscles and ligaments. The muscular elements include nearly all those that have to do with the function of the hand, wrist, and fingers, the short muscles being of particular importance. Of the ligaments, there are many small ones connecting the individual bones, while more superficially on the palmar side is the strong annular ligament, and beside this the palmar fascia is of very considerable importance. In the space made by the arch of the carpal bones and the annular ligament run the tendons of the long flexor muscles as well as the nerves and blood-vessels which supply the hand.

FIG. 4.—High arched hand. Note the narrow width of the carpus in relation to the length from radius to metacarpus. Note also narrow width of carpus to length of hand and fingers.

With the carpal arch, as with the tarsal arch, the height is not constant. At times it is relatively high (Fig. 4); at other times low (Fig. 5), with the average a more strictly normal between, and this is true not only of the transverse arch, but also true of the arch formed by the first row of bones into which the os magnum and unciform bones fit. In the high arch the line of the carpo-metacarpal joints is nearly straight across the hand (Fig. 4), while in the low arch or the high arch which has given way, the line is curved convex forward (Fig. 5).

Not only is this true, but the shape of the trapezium, especially the shape of the articulation against which the first metacarpal bone rests,

FIG. 5.—Low arched hand. Note breadth of carpus in relation to the distance from radius of metacarpus. Note also breadth of carpus in proportion to length of hand. Contrast with FIG. 4.

varies within considerable limits. At times the plane of the articulation is nearly horizontal (Fig. 4); at other times the axis has a marked oblique inclination (Fig. 6). The effect of such difference upon the stability of the joint is probably at once apparent. If the axis of the joint is oblique there is a natural tendency for the metacarpal bone to slide off the trapezium whenever the muscles are tightened and the thumb is held straight in the line with the other fingers. The only time when the bone rests firmly against the articulation is when the thumb at its base is abducted. This obliquity will increase as the arch flattens and will be lessened by heightening the arch. In the natural use of the hand in everything that involves the use of much strength,

Fig. 6.—Moderate degree of flat hand. Note the way in which the scaphoid has fallen away from the os magnum. Note also the oblique axis of the joint of the trapezium against which the first metacarpal rests.

especially in grasping objects, the thumb is flexed at the phalangeal and metacarpo-phalangeal joint but is extended at the carpo-metacarpal joint. In this position the metacarpal bone rests squarely against the articular surface on the trapezium, and the application of the force in the contraction of the muscles holds the base of the metacarpal bone firmly in place. Any action made with the thumb straight and in line with the other fingers must necessarily mean strain to the carpo-metacarpal joint, with a tendency for the first metacarpal to slide off the trapezium.

FIG. 7.—Naturally high arched hand with arch flattened. Note the flattening of the first row of carpal bones with the scaphoid separated from the os magnum. Also the trapezium and pisiform are displaced outwardly. Compare with corrected position in Fig. 8.

If such a condition of partial displacement of the base of the first metacarpal is present, the effect of the contraction of the muscles of the thumb, both extensors and flexors, is exerted abnormally, and it becomes increasingly difficult to flex the thumb at the metacarpo-phalangeal joint. Under such conditions, instead of the thumb flexing, the muscle pull still farther displaces the base of the first metacarpal and results in hyperextension instead of flexion of the metacarpo-phalangeal joint, with possible slight flexion of the phalangeal joint.

If with such a joint the ligaments become strained or the carpal arch becomes weakened so that the inclination of the axis of the joint is still further increased, displacement of the metacarpal bone outward be-

FIG. 8.—Correction of flattening of arches with wrist strap. Same case as Fig. 7.

comes a matter of great ease, with the result that many times the displacement becomes permanent and results in marked disability.

The condition of the carpal arches as to strength and the position of the bones depends, as is true of the tarsal arches, largely upon the tone of the muscles, the ligaments naturally not being materially stretched unless the muscle tone has become so weakened as to throw the strain upon the ligaments. As is true also of the tarsal arch, a condition of marked relaxation of the bones and flattening of the carpal arches may exist without material interference with the function of the hand. This, of course, is to be explained by the fact that the tone of the muscles is such that they are able in their contraction to easily draw the bones together and hold them in proper position to enable the normal function to take place. If, however, the tone of the muscles becomes lowered as the result of sickness or inactivity, the condition then be-becomes a matter of much more seriousness. At such times not only is

it impossible for the normal relation of the bones to exist without proper tone of the muscles, but it is equally impossible for the proper tone of the muscles to develop unless the proper relationship of the bones and the maintenance of the arches exists. At such times the muscles may be able to draw the bones into place, but they may not be of sufficient strength to keep them there during use of the hand. This was exactly the condition (Figs. 7 and 8) when the use of a support was absolutely necessary in order to make use of the hand possible without pain and in order to allow the ligaments and muscles to strengthen.

To appreciate fully the importance of the proper tone of the supporting structures of the arch in connection with the function, it should be remembered that the tendons of the long muscles, which flex the fingers and thumb pass under the annular ligament and on the ulnar side, exert their force partly around the hook of the unciform as a fulcrum. On the radial side the trapezium becomes the fulcrum, and upon this side, because of the strong thumb flexors, the force exerted is greater

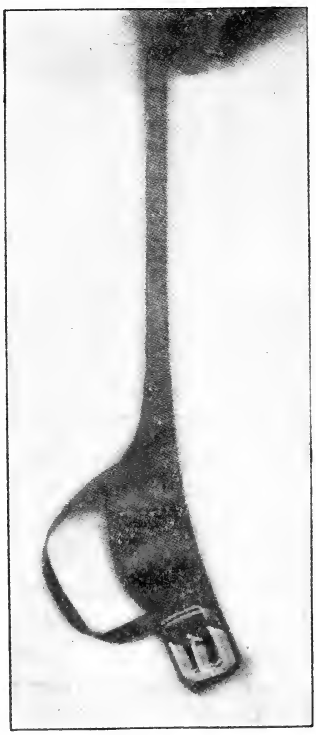

FIG. 9.

than that which is received upon the unciform. As long as the arch is well maintained the bones hold the tendons well in place, but when the arch flattens the whole palmar surface spreads, with the natural result that the hook of the unciform slopes outward instead of inward, and the trapezium becomes an inclined plane, off which the tendons must slide into the soft structures. In this position the tendons not only are unable to work rightly, but tend in their contraction to still further spread or flatten this arch. In this position, also, the extensor tendons, which should pull across the back of the first metacarpal and hold it in place, must exert their pull at the side of the base and still further force the bone out of place. Not only this, but the extensor tendons, especially the extensor secundi internodii pollicis, are strained in their grooves on the outer side of the lower end of the radius, with developing pain at this point. The clinical picture of pain referred to this point at the "base of the thumb," but actually over the outer face of the radius, is to be explained commonly in this manner.

The treatment of such conditions naturally consists, first, in restoring the bones to their proper position, and in the second place improving the tone of the muscles and ligaments, in so far as is possible, to maintain this position. Many times the condition is entirely an expression of weakness, and properly supervised exercises will be all that is required. At other times, because of the peculiar application of the force of the flexor muscles to the trapezium and to the hook of the unciform, it is necessary to temporarily supply some form of support un-

FIG. 10.

FIG. 11.

til the muscles and ligaments can have regained enough of their normal tone so that this support can be dispensed with. The support that has given the greatest satisfaction to the writer is pictured in Figure 9. This consists of a strap buckled about the wrist (Figs. 10 and 11), making pressure over the lower part of the carpus, with two pads which fit over the base of the first metacarpal and the trapezium. The pads are so placed that the extensor tendons pass between them, and the strap is held in place by another strap which passes around the thumb, which in itself tends to favor the reposition of the base of the metacarpal by holding the thumb in the abducted position. The effect of such a strap upon the position of the bones, and especially in the relation of the first metacarpal to the trapezium, is well shown in Figure 8. The restoration of the position of the scaphoid with reference to the os magnum is clearly shown. Before the strap was applied the first row of carpal bones was so flattened that the scaphoid fell away from the os magnum, carrying with it the trapezium and the trapezoid, and, consequently, the thumb and index finger. With the strap in place the flattening of this first carpal row is corrected and the scaphoid is drawn up into place so that it rests firmly against the os magnum with the index finger and thumb in their normal relation to the rest of the hand.

In the severe cases it is necessary, at times, to manipulate the bones to replace them and to hold them temporarily in fixed dressings, these being gradually discontinued, with exercises and the lighter supports later on substituted. If as a result of disease it becomes necessary to allow a stiff joint at the first carpo-metacarpal articulation, care should be taken that the first metacarpal is fully replaced so that proper approximation of the thumb to the ball of the other fingers becomes possible.

OPEN REDUCTION OF AN OLD CONGENITAL HIP DISLOCATION.

BY MAURICE A. BERNSTEIN, M.D., CHICAGO, ILL.

THE manipulative, or so-called bloodless method of reducing congenital dislocation of the hip-joint, has held the field since 1897, when Lorenz[1] and Paci[2] accomplished their first successful reduction. Although the manipulative method has, in a fair percentage of young children, given excellent results, one is never certain of a perfect anatomical reduction, and the injury to the soft structures, and possible fracture of the femur (an accident not uncommon), makes the procedure quite formidable. Moreover, its results are doubtful, or poor in many cases; unsatisfactory in a great number of bilateral cases; and not applicable in young adults. The open method of reduction is in these cases the only hope, and even Lorenz and Bradford, determined advocates of the manipulative method, have devised a plan for open reduction of the intractable cases.

Recent literature shows that the pendulum is beginning to swing toward the open method, and there seems to be a feeling that with an improved technique, and more experience with the open reduction, a method will be evolved which will be superior to the "blind" bone-setting method of manipulation. There will always, however, be a large number of cases that will yield to the closed method of correction, and manipulative reductions should first be attempted, but the open method will be resorted to in a greater measure than heretofore.

It will be of interest to give a brief review of the subject:

The modern surgical treatment may be said to have commenced with Pravaz[3], who in 1838 supplemented the old and only method of treatment by extension, abduction, and pressure of the great trochanter. This method was later revised by Buckminster Brown[4], and Adams[5] published an important paper, with case illustrations, in 1895. Roser[6] did a successful resection of the head of the femur for the condition in 1874, which Reyher[7] repeated in 1882. Koenig[8] detached a periosteal flap from the great trochanter and neck of the femur, turned it upwards, placed the head of the femur in contact with the ilium, and stitched the flap firmly to the head. A variation of this method was

devised much later by Tubby[9], who drilled a hole in the head of the femur, and passed three stout silk strands through it; these were carried through the periosteum of the iliac bone as near as possible to the normal acetabulum, and the ends tied. Thus the head of the femur was sutured to the iliac bone. In 1884, Margary[10] advanced the open treatment by his method of excavating a new acetabular cavity behind its usual position, and in the following year Ogston[11] formed a new acetabulum above the normal position. Poggi[12], in 1888, was entirely successful in a case where he excavated the acetabulum by Margary's method with some modifications. Witzel[13], and others, endeavored to nail the head of the femur against the iliac bone to obtain a point of support and create an obstacle to the upward displacement of the head. The shortening was first corrected by strong traction, and windows were cut in the plaster cast over the great trochanter, an oblique incision was made over the great trochanter through which the nailing was done. Kirmisson,[14] since 1900, has practised a similar method, using ivory pegs.

The various methods mentioned had, however, a very limited application, and in the year 1890, when Hoffa[15] described his operative method, attempts at surgical reduction were nearly always futile. In this year Hoffa did his first successful operation, which consisted in deepening the acetabular cavity by scooping out the contained fat, synovial membrane, articular cartilage and bone. Hoffa made an oblique incision from the anterior superior iliac spine downward and backward over the great trochanter, exposing the joint between the gluteus medius and minimus muscles. In approaching the joint, the tensor fascia femoris, sartorius and rectus femoris were severed. All the muscles attached to the greater and lesser trochanter were also severed and the capsule opened. Hoffa's method was not new, as it was used by Margary and Poggi before him. This method has since been tried by others and proved unsuccessful because the trauma to the joint produces ankylosis.

Lorenz[1] operated according to Hoffa's method in 1892, but he subsequently modified the method by omitting severing the trochanteric muscles and by approaching the joint by an incision from the anterior external surface. This has been termed the Hoffa-Lorenz method.

Bradford[16], in 1905, incised the capsule, dilated or cut the constricted portion or neck of the capsule, replaced the head of the femur and stitched the capsular flaps in such a manner that when cicatrization took place a new cotyloidean ligament was formed so as to hold the

FIG. 1.—Roentgenogram of the hip-joint taken before operation, showing the head of the femur high up on the ilium. The rim of the acetabular cavity can be made out definitely on the roentgenogram. The head is of good form and bears the normal relation to the neck.

head of the femur in place. This method, in a measure, corresponds to the one employed by Galloway[17], who opens the capsule and dilates the constricted portion. Galloway points out that it is impossible to pass the head of the femur through the constricted, narrow capsule by the blind method. Clark[18] opens the capsule at the lowest point of its posterior surface, and the periosteum and cotyloid ligament are detached for about one-half inch at the upper posterior border of the acetabulum. Three stitches are passed through the periosteum into the joint cavity under the cotyloid ligament, then out of the joint and through a fold of capsule and tied. These stitches take up the slack in the posterior portion of the capsule and hold the cotyloid ligament over the outer part of the head of the femur. Tubby[10] opens the capsule

FIG. 2.—Roentgenogram of the hip-joint taken after operation, showing the head of the femur in the acetabular cavity. The limb is slightly abducted.

by a crucial incision over the head of the femur. The constriction is overcome and the head replaced. Albee has introduced an entirely new method of obtaining retention of the reduced hip in a shallow acetabular cavity. The posterior superior lip of the acetabulum is pried downward and outward to overhang the head of the reduced femur and prevent it from slipping up. The piece of acetabulum is held in place by a wedge-shaped piece of bone obtained from the tibia. The method has recently been modified by Fordyce Jones.[20]

The case which I wish to report here is a congenital dislocation of the hip-joint in a girl twenty-one years of age, who was operated on at Michael Reese Hospital, February, 1921. The dislocation was no-

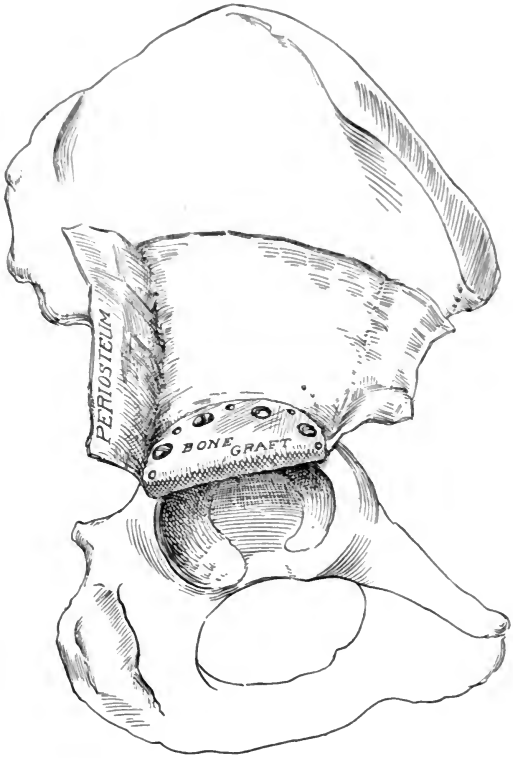

FIG. 3.—Illustration of the bone graft over the superior border of the acetabular cavity when the outer lip is poorly developed. The bone graft is taken from the crest of the ilium and is shaped so that it corresponds to the outline of the acetabular cavity. The reflected portion of the periosteum is sewed over the graft together with the muscles that are attached to it.

ticed when she first began to walk, but no effort was made at that time to reduce the deformity. On examination it was found that she had four inches of shortening of the left leg, walking, therefore, with a marked limp and considerable discomfort. There seemed to be no stability of the hip-joint, and she was distressed when she made a mis-step. She was determined that something be done to correct the deformity, although she was advised by others as well as myself that the operation was of a serious nature, and that the outcome would be uncertain.

On examination of the x-ray plates (Fig. 1), it was seen that the head of the femur was displaced high up on the ilium; it was well formed and bore the normal relation to the neck, so that there was no

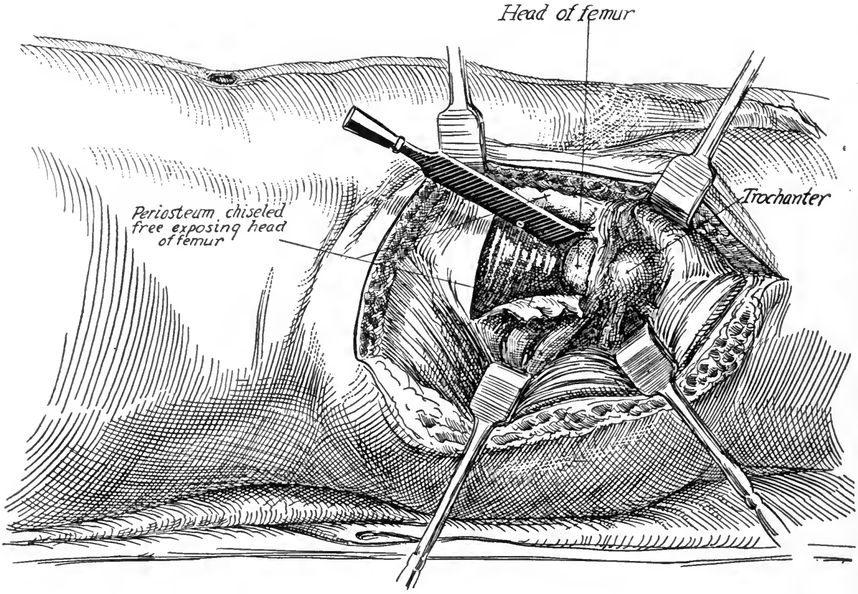

FIG. 4.—Drawing showing the Smith-Petersen incision. The muscles are retracted and the head of the femur exposed and found on the iliac bone.

coxa vara present. The acetabular cavity presented a very good outline, and seemed of fairly good depth. It appeared, therefore, that if the head of the femur could be brought down and placed in the acetabular cavity it could be made to stay there without much difficulty.

Before attempting this operation I had planned a method which I developed upon the cadaver, to be applied in congenital dislocation of the hip, where the acetabular cavity is shallow. This method consists in removing a portion of the outer lip of the iliac crest, placing it over the upper lip of the acetabular cavity, and fixing it there by means of bone screws. The bone transplant is to act as a shelf to prevent the head of the femur from slipping out after reduction (Fig. 3).

I did not employ this method upon this patient, since the acetabular cavity was of good depth.

The usual preparations of the extremity were made and the patient placed upon the Hawley table without traction. The incision employed was the Smith-Petersen[21], which is as follows (Fig. 4):

The incision begins at a point about three or four inches below the anterior superior iliac spine, and is carried forward following the outer border of the sartorius muscle to the anterior superior spine. It is

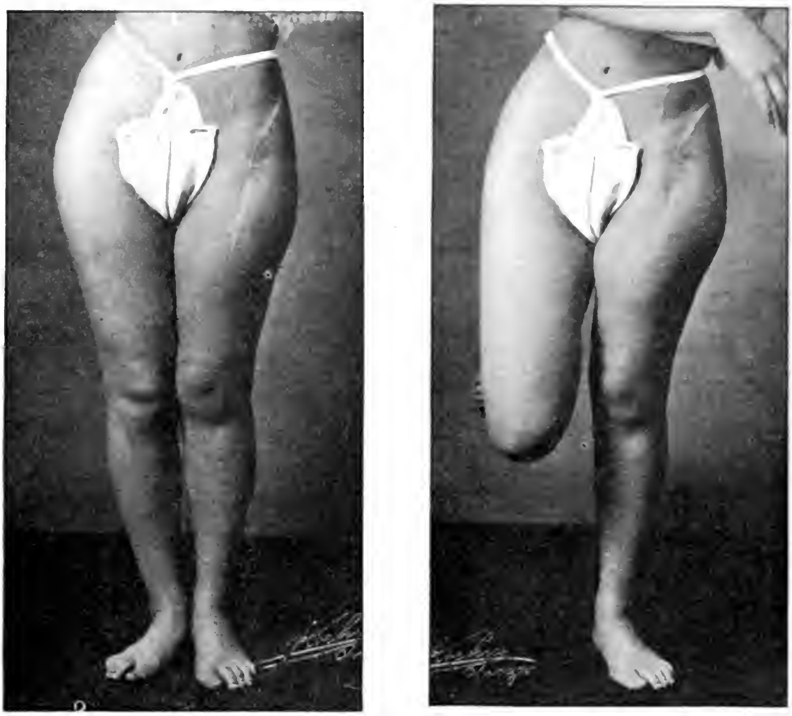

Fig. 5.—Photograph of patient taken five months after operation. The scar indicates the line of incision. The dimpling of the skin is due to a superficial infection. There is motion of the hip-joint in every direction. In the picture to the right the patient is seen standing upon the operated extremity. There is no shortening by actual measurement.

curved backward, following the crest of the ilium for a distance of about two to four inches. The line of incision can be seen from the scar in the photograph of the patient taken after the operation (Fig. 5). The gluteal muscles were then readily stripped down, with the periosteum of the ilium adhering to them, leaving a wide exposure of the hip-joint. The attachment of the rectus muscle at the anterior superior iliac spine was sectioned, so that the tension at the hip-joint was partially overcome. The head of the femur was now easily felt with the finger, and appeared normal in outline. The capsule of the joint was incised, exposing the femur, which was small and somewhat pear-shaped. The capsule was very much elongated and constricted, so that it looked like an hourglass. With a chisel the surrounding tissue and periosteum at the ilium where the head was fixed were stripped as far down as the upper surface of the acetabulum, carrying the

capsule and femoral head downward. An attempt was now made to replace the head into the acetabular cavity, but it did not yield.

Traction was applied with great force and the head was brought opposite the acetabular cavity; it seemed impossible to effect the reduction of the head over the outer rim of the cavity. The posterior portion of the capsule had to be sectioned as it gave considerable trouble in following the head of the femur. Having with great effort replaced the head in the cavity for about half its circumference, complete reduction was finally effected as follows: A few thicknesses of gauze were placed over the great trochanter, with the head partly retained in the acetabular cavity; then the head was driven further into the cavity by hammering gently but firmly on the great trochanter. The object in view was twofold: first, to avoid scraping or breaking down the acetabular contents with a sharp instrument and thus produce a later ankylosis; second, if the head could not be retained by the usual method, it could be impacted into the acetabulum. The head, however, entered and remained there. The rent in the capsule was sewed and overlapped so that a reefing was accomplished. The capsule was also sewed with heavy kangaroo tendon to the outer lip of the acetabulum. The muscles surrounding the joint were sutured in place, and the skin was closed with plain catgut. The limb was put in plaster of Paris in extreme abduction.

The postoperative course was stormy. The patient had considerable pain, and became hysterical, almost maniacal, and continued so for some time. No sedative was strong enough to combat the apparent pain. She was seen by several neurologists, who were of the opinion that the girl was impressed with the seriousness of the operation to such an extent that it brought about an hysteria. I injected the sciatic nerve and also the sacral canal, but there was no relief. There was no pain at any time over the hip-joint itself. The pain was in the ankle and along the outer side of the leg, along the course of the external popliteal nerve.

X-rays were taken after the operation and showed (Fig. 2) the limb in good position, and the head of the femur in the acetabular cavity. Eight weeks after the operation the cast was removed, and it was found that there was free motion in every direction of the hip-joint, and that there was no pain on moving the leg. There was some anesthesia and areas of analgesia of the skin around the leg and also a loss of reflex. There was present a distinct foot drop. All these symptoms, however, cleared up, and the patient now walks with but

little distress or discomfort, using a cane. She is able to walk up and down a flight of stairs, and is able to flex and extend the ankle, but has little power as yet in her thigh muscles, which have become more or less atrophied from disuse.

COMMENTS.

The capsule was found elongated and folded over the head of the femur like a sleeve. When the femur was everted the capsule was found enormously long. A constriction was found about an inch below the head of the femur. When the capsule was incised the constriction did not permit the entrance of the little finger. The posterior portion of the capsule did not permit the reduction of the head since it blocked the acetabular cavity, and followed the head at each attempt at reduction.

The acetabular cavity was well formed, having a sharp upper surface and well-developed outer lip. The cavity was subdivided into two compartments, a superficial one large enough to admit part of the head of the femur, and a deeper one much larger, slanting backward and upward. A ridge of bone separated the two, and was easily broken down in the process of forcible reduction so that the two cavities were joined into one.

Nerve injuries: As a result of traction and tension, injury resulted to the lumbo-sacral plexus. The injury was principally to the origins of the anterior crural and external popliteal nerves. Both these nerves have a posterior origin from the lumbo-sacral plexus. The anterior crural has a higher origin; it arises in the substance of the psoas major muscle from the back of the second, third, and fourth lumbar nerves. The external popliteal arises from the posterior part of the sacral plexus from the fourth and fifth lumbar, first and second sacral nerves. The anterior crural has a more superficial course in the pelvis, passing downward in the groove between the psoas and iliac muscles, and therefore subjected to greater trauma.

SUMMARY.

The difficulty in reducing a congenital dislocation of the hip-joint increases with the age of the patient. The chief difficulty in reducing a luxation by the closed method is the inability of passing the head of the femur through the narrow neck of the capsule. This has been

recently emphasized by Galloway. When the head is once reduced it can be retained by the usual method. In older individuals the depth of the acetabular cavity and shape of the head of the femur are not the chief considerations for a successful reduction. Shortness of the soft structure, muscles, nerves, and blood-vessels are great obstacles. At the age of fifteen or twenty, the muscles, nerves, and blood-vessels have become normal for that individual, and to overcome shortening of four or five inches is a great task. It is therefore necessary to sacrifice muscular attachments. In performing this operation one should first inject the sacral canal to overcome the distressing pain from nerve stretching. One must also take particular care not to injure the blood-vessels. In our case there was no evidence of circulatory disturbance.

I wish to thank Dr. Edwin W. Ryerson for valuable assistance and suggestions in connection with this case.

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FURTHER OBSERVATIONS UPON USE-DESTRUCTION IN JOINTS.

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WHEN I came upon the first specimens of surprising destruction consequent upon use in the shoulder-joint, described in 1915, I quite naturally tried to account for them by assuming that they proceeded from pathogenic causes. I soon realized, however, that such an assumption involved insuperable difficulties, and hence indicated my doubt in the title of that article. However, since the destructions there recorded were so extensive, I was, in spite of my doubts, unable to give a satisfactory explanation for them upon any other basis. Nor could I believe at that time that pathologists or orthopedic surgeons had not already observed and described these startling destructions. The many events in the life history of an individual which remain unknown, especially to the anatomist, and a lack of sufficient experience of pathologic conditions, no doubt, have been largely responsible for failure to recognize the true significance of these and other destructive changes met with in the dissecting room and reported in 1915 and 1920.[1, 2]

The evidences of what I have come to regard as purely functional destructions are too numerous to escape the attention of anyone who carefully follows routine student dissections, but it is easy to attribute them to arthritis and to leave it at that. Perhaps there also has been a feeling that the dissecting room could offer nothing new. Yet, it is exactly here that the minutest necropsies are made; although, to be sure, whether or not the opportunity can be utilized to the fullest extent depends upon many considerations, but mainly upon a knowledge of gross pathological changes by the anatomist.

Since the publication of the first six cases eight years ago, I have paid particular attention to articular changes which do not seem to have resulted from infectious conditions. I fully realize that whether or not changes found in a particular cadaver have or have not resulted solely from an infectious process may be difficult or impossible to de-

termine, but in the course of a decade the evidences have become so abundant and the testimony offered by them so unequivocal, that I no longer can entertain the least doubt regarding the true significance of the changes in question.

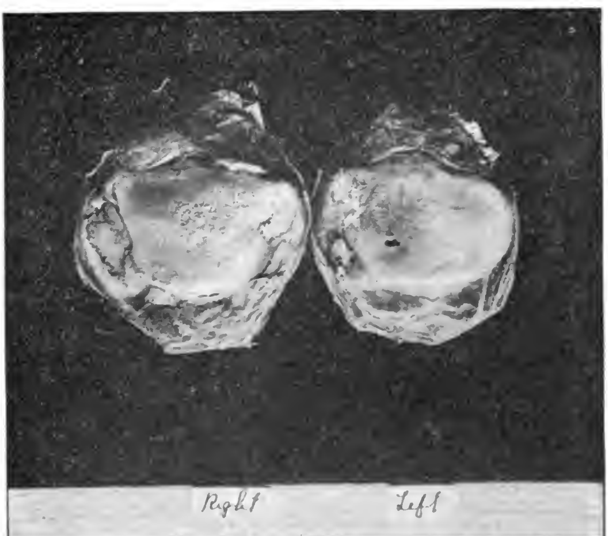
Every one is familiar with the erosion of the skin of the palms of workmen and with the evidence of wear on the permanent teeth shown in such marked degree, especially in many Indian skulls. The well-known effect upon the teeth of the persistent use of a pipe is a related phenomenon, and other more infrequent instances of what may be termed use-erosion upon the external surfaces of the body easily will come to mind. A few individuals outside the rank of anatomists also may be familiar with the relation between the degree of wear in teeth and certain correlated asymmetries of the mandibular condyles and the glenoid fossae of the skull.

It must not be overlooked, however, that it is necessary to discriminate between erosion which is truly functional and that which is only incidentally so. The teeth during mastication, for example, are worn directly through use. The skin and hair, on the other hand, are worn indirectly through use of a part which they happen to cover. However, the bursae in question here are destroyed directly through use made of them in the movements of a part with which they are related, and the same thing holds for the ligaments and joint capsules involved. The tendons concerned also are destroyed in this active manner through direct use in the execution of movements which are effected partly or at least influenced by them. Yet it is important to note that these tendons and ligaments do not suffer destruction directly from the tension made upon them by the contraction of the muscles to which they belong, but through contact with bony surfaces with which they happen to come in contact in the course of movements. Hence in the last analysis their destruction, too, is incidental and indirect. In case of the cartilages concerned, however, the destruction is a directly functional one, for they are worn away while playing the rôle for which they would seem to exist.

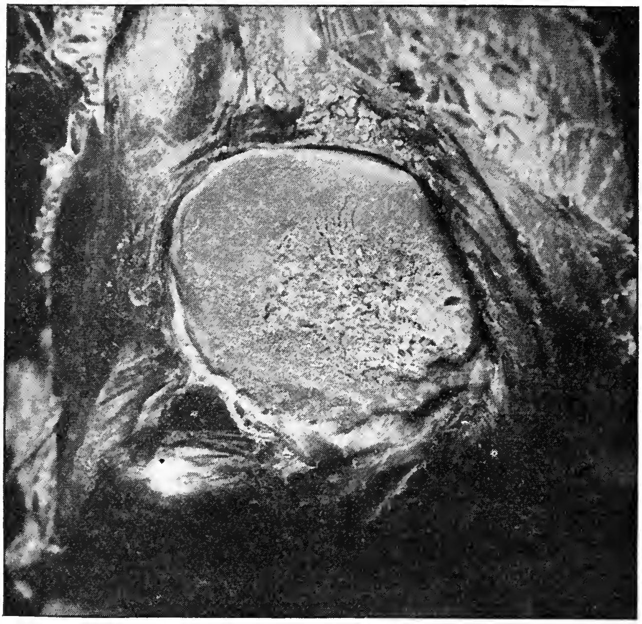
It has been a time-honored belief that the articular cartilages do not wear from use alone and that defects in them are always due to traumata or to arthritides. Yet it is not uncommon to find that the articular discs in the temporo-mandibular articulations may be destroyed almost completely through use. I say this in spite of the fact that, as generally assumed, these discs may rarely be defective developmentally, for the contrast between those from young adults and oc-

togenarians is very striking. The conditions referred to in these discs cannot be attributed to simple atrophy, that is, to senility itself, for any lack in vigor in the use of the muscles of mastication because of advancing years would seem to be compensated for by a more prolonged, even if a more inefficient, mastication. Moreover, the proverbial greater loquacity of old age would also tend to counterbalance any deficiency in the use of the mandible due to other causes.

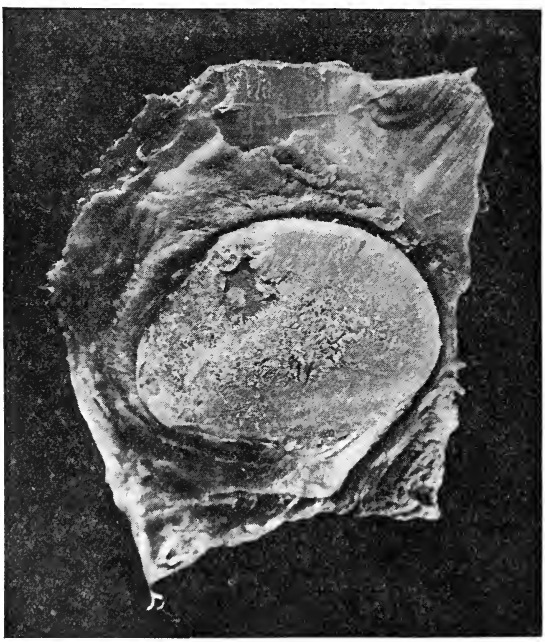
But the internal effects of use are not limited to these or to other interarticular discs, for not infrequently the fibro-cartilage over the mandibular condyle is reduced to a very thin layer of extremely hyaline, fibrous connective tissue containing nothing but a few remnants of nuclei. Moreover, it may be eroded completely in certain areas of contact. Since these destructive changes have been noted in temporomandibular joints, the articular capsules of which appeared wholly normal, it hardly seems as though one can rightly attribute them to infectious processes, particularly not since wholly comparable instances of erosion of articular cartilages with polishing of the underlying bone occur not uncommonly also elsewhere. I have seen a number of such instances in the phalanges of both hands and feet and also in the carpals and tarsals. Since articular cartilages are regarded as especially resistant to infectious changes, it would seem that infections, if of sufficient duration to result in complete destruction of the cartilages,



(1) Slight roughening of the cartilages on patellae from a man of 64 years.



(2) More pronounced roughening of the cartilage upon the left patella from a seaman of 83 years.



(3) Similar but still more pronounced changes upon the patella from a housekeeper of 74 years.

(4) Marked erosion upon the distal extremity of the ulna and lunatum from a seaman aged 83. The lunatum is reflected distally with the capsule.

surely would result in a considerable thickening of the articular capsule and necessarily would produce other easily recognizable structural changes, as well as symptoms and signs of arthritis.

It is a very common thing to find undoubted evidence of wear on the sagittal ridge of the patella from wholly normal knee-joints. All grades of wear can be seen in otherwise wholly normal joints from the slight roughening shown in Figure 1, to the more marked changes shown in Figures 2 and 3, even to complete erosion of the cartilage over certain areas with polishing of the underlying bone. The same thing holds for the distal extremity of the ulna, the styloid process of which not rarely is polished from contact with the triquetrum and may even be completely destroyed by the erosion. Similar phenomena are found on the distal extremity of the radius also. An exceptionally fine example of complete destruction of the fibro-cartilage on the distal ex-

(5) Complete erosion of the articular cartilages with considerable destruction of bone and exquisite polishing of the pisiform and triquetrum from a housekeeper aged 74.

tremity of the ulna with some erosion of the styloid, the lunatum and head of the ulna through the movements of pronation and supination is shown in Figure 4. The triquetrum does not show well in this illustration but marked erosion is evident upon the periphery of the head of the ulna and upon the corresponding surface of contact of the lunatum. Although the fibro-cartilage was completely destroyed in this case, no evidences of arthritis were present.

That use alone can result not only in complete destruction of the cartilages but in considerable destruction of bone also is splendidly illustrated by several instances of wear between the pisiform and triquetrum, such as represented in Figure 5. Although this joint was otherwise entirely normal, not a particle of the articular cartilage was left upon the surfaces of contact between these bones. Furthermore, considerable amounts of the entire articular surface of both bones had been removed by friction. Yet the coapted surfaces fitted perfectly and were so highly polished as to reflect light like a mirror, as shown in the illustration. Varying degrees of erosion of cartilage and bone are extremely common between these two bones in wholly normal joints, a fact which accords well with the explanation offered here for these changes.

(6) Lateral view of the right shoulder joint with deltoid reflected, from a sailor aged 64. Note especially the thin, opened subdeltoid bursa, the small capsular defect and the slight fraying of the external surface of the articular capsule.

Similar though less complete effects of erosion are shown also in the shoulder-joints described in the above articles. Although the articular cartilages, both on the humeral head and in the glenoid cavity of the scapula, are wholly normal in some of these joints, they are completely eroded over considerable areas, with polishing of the underlying bone in others. The presence of an infectious process as a primary cause for these changes can be excluded with considerable certainty, for the minor secondary changes noticeable in the surrounding soft parts and in the adjacent bone in some specimens could result from non-infectious, inflammatory changes resulting from the trauma incident to the excessive use which caused the destruction.

(7) The left shoulder joint from the same case. Note especially the clean-cut outer margin of the coraco-acromial ligament and the small bony excrescences in the capsular defect.

Since most of the twenty cases of partial or total destruction of the superior portion of the humero-scapular articular capsules were characterized also by destruction of the subdeltoid and subacromial bursae, I thought it not improbable at first that the destruction of these bursae usually is the first step in the destructive changes in the shoulder-joint previously reported. Very recently, however, I have come upon arms in which these bursae, if originally separate, had fused and become considerably enlarged. All these bursae had very thin normal walls adherent to the acromion and all extended distally over the humeral tuberosities. Yet the region of the latter and the inferior surface of the acromion showed clear evidences of friction in the fraying of the soft tissues which cover them. Moreover, the joint capsules were locally deficient in several of these arms, two of which were from the body of a "sailor," another from a "seaman," and several from

(8) Anterior view of the right shoulder joint from a seaman aged 83, showing a large anterior capsular defect, the upper portion of which is bounded by the exposed, slightly-frayed portion of the tendon of the long head of the biceps, the superior humero-scapular ligament and the adjacent portion of the articular capsule. Note the fraying and the second defect, shown in the next figure, at the top of this illustration and the clean-cut margin of the coraco-acromial ligament.

housekeepers. The triangular defects in the capsules of the paired arms shown in Figures 6 and 7, were located directly cranially to the greater tuberosity and measured 5 x 15 and 4 x 7 mm., respectively. Both defects slightly involved the anterior border of the tendon of the supraspinatus near its insertion, but the remainders of the superior portions of the capsules and the entire articulations were but slightly affected. The anterior margin of the coraco-acromio ligament of the left arm, shown in Figure 7, was worn to a knife-edge, and areolar tis-

(9) Superior-lateral view of the same specimen, showing the upper capsular defect with the humerus in internal rotation. Note the thin, well-defined margin of the tendon of the supraspinatus located dorsally to the defect, and the thin reflected subdeltoid bursa.

sue and the fibrous expansion ordinarily extending from the tendon of the coraco-brachialis to this ligament had been worn away completely.

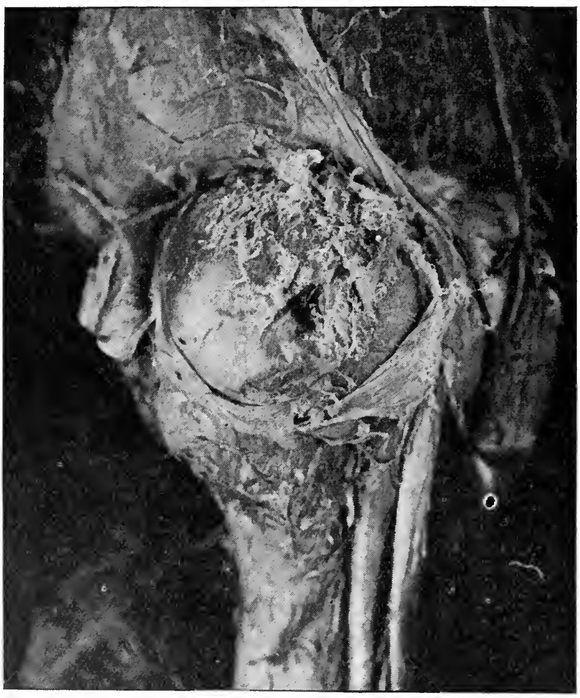
The superior portion of the capsule of the shoulder-joint of the right arm from another cadaver contained two larger defects, one lying on either side of the tendon of the biceps which still was covered by the narrow adjacent strip of capsule, including the superior gleno-humeral ligament. The anterior defect is shown in Figure 8, and the lateral in Figure 9, in which the deltoid and the wall of the subjacent bursae are reflected. The anterior margin of the tendon of the supraspinatus which forms the dorsal boundary of the latter defect not only is entirely exposed but is worn to a fine edge. The tendon of the biceps which forms part of the dorsal border of the anterior defect is exposed and frayed, its synovial sheath having been worn away by contact with the acromion in external rotation and abduction. The soft tissues on the under surface of the coracoid also were frayed.

The fraying of the entire dorsal surface of the joint capsule in this

(10) Dorsal view of the same shoulder, showing the reflected bursal wall and marked fraying and trabeculation of a bursal septum.

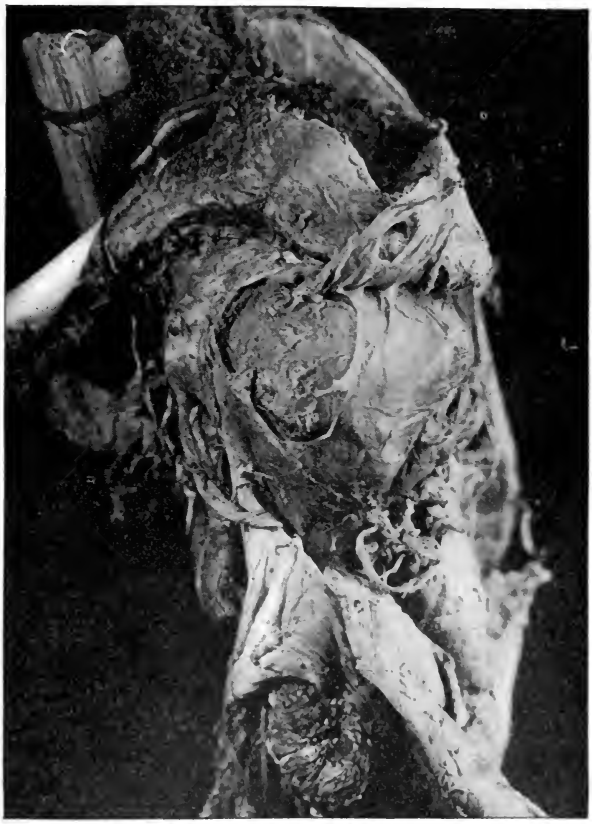
shoulder is well-shown in Figure 10, in which the effect of wear is seen also upon the internal surface of the reflected deltoid near its acromial attachment. This figure also shows marked fenestration of a thickened dorsal septum in the subdeltoid bursa, the thin outer wall of which has been partly reflected. This is entirely comparable to similar findings in the interbursal septa in the prepatellar and the olecranon regions, described in a former article (Meyer, 1920). In spite of these pronounced effects of wear in the capsule and bursa, the tendon of the biceps, which is shown in Figure 11, is in a still earlier stage of division from contact with the greater tuberosity than that represented in Figure 3 in the above article. Evidences of wear of the soft parts are present also upon the inferior surface of the acromion, but the articular cartilages are wholly unaffected and no bony polishing is present.

(11) Internal surface of the tendon of the long head of the biceps from the same case. Note the fraying of the tendon and the reflected, normal synovial sheath in the distal (lower) portion of the tendon.



(12) Lateral view of the right shoulder joint from a housekeeper aged 74, with the deltoid reflected upward. Note especially the small capsular defect and the fraying of the capsule.

(13) The tendon of the biceps from the same case with the scapular attachment to the left. Note the slight fraying to the left of the middle and below on this tendon.



(14) Anterolateral view of the left shoulder from a housekeeper aged 74. Note the bursal defect and the fraying of the underlying capsule.

Similar conditions exist also in the shoulder-joint from a "housewife" shown in Figure 12. In this shoulder the capsule also contains a small defect and is frayed very remarkably, although the large subdeltoid bursa was intact and very thin-walled. The tendon of the biceps of this case was frayed only very slightly, as shown in Figure 13, for the small capsular defect did not permit the greater tuberosity to come into free contact with the tendon.

The first two of these arms, in which the cartilages of the shoulder-joint also were entirely normal, represent the earliest stages in the formation of capsular defects which I have seen, but they do not exemplify the earliest stages in this process of joint destruction. These are represented by instances in which only the external surface of the articular capsule or the external surface of the subdeltoid bursa is frayed slightly. The left shoulder-joint shown in Figure 14 shows a fairly early stage, for in this case the wall of the subdeltoid bursa only was destroyed. It may also be noted that the outer wall of the subacromial portion of the subdeltoid bursa, or that of the subacromial bursa itself when present as a separate sac, apparently becomes firmly adherent to the inferior surface of the acromion process in these cases. After becoming adherent the subacromial portion of the bursal wall then is destroyed by being ground against the acromion.

All tendons of the biceps shown here are in early stages of division, no doubt because the defects in the articular capsules are so small. It is evident that as soon as these defects become large enough to permit the greater tuberosity to pass into the articular capsules, when the arm is brought into a position of marked abduction, it enters the joint cavity and comes into free direct contact with the tendon. The rate with which abrasion of the tendon of the biceps then occurs depends, no doubt, upon the exact use to which the arm is being put. If the arms from which these tendons were taken are abducted so that the greater tuberosities of the humeri pass through the defects in the upper capsule, then the coracoid processes pass directly over the anterior capsular defects. But these defects do not result from contact with the coracoid, for quite contrary to the greater tuberosity, which frequently is polished from contact with the inferior surface of the acromion, the corresponding surface of the coracoid never was found polished. This, no doubt, is due to the fact that bony contact between the region of the tuberosities and the coracoid does not normally occur.

The only instances of bony erosion of the coracoid which I have seen came from the cadaver of a woman who died from a pronounced cancer

(15) Anterosuperior view of the left shoulder joint from a sailor aged 69. Muscles removed to show the complete destruction of the upper half of the capsule and the perfect preservation of the cartilages.

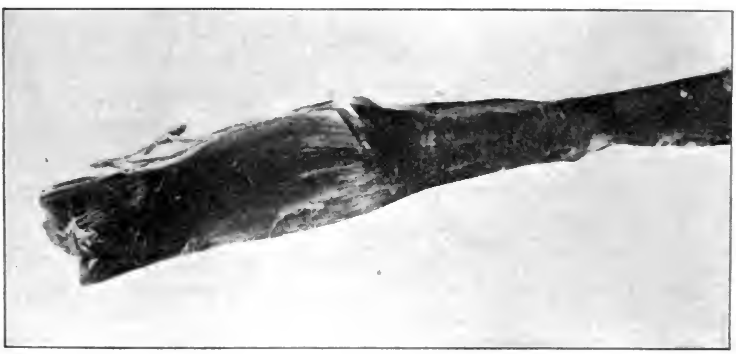
en cuirass some time after ablation of both breasts. Since the neoplasm had invaded the pectorales as well as metastasized to the heads of both humeri, it is highly probable that muscle spasm and contractures were responsible for approximation of the humeral heads to the coracoids in this case. Moreover, it was very clear that the coracoids, which had been reduced to less than half their normal thickness, were not worn down through contact with the humeral tuberosities but through contact with the heads of the humeri. Hence, although the external surface of the articular capsule may become worn in its anterior portion merely by being folded between the coracoid and the region of the anterior tuberosity, capsular defects probably do not result in this way. That this actually is the case is suggested not only by the fact that the defects located in this portion of the capsule are produced by contact with the acromion in a position of external rotation and abduction of the arm but also by the fact that only the soft tissues on the inferior surface of the coracoid are frayed in these cases.

(16) Superior view of the left shoulder from the same case, with deltoid reflected, illustrating the same things.

That very extensive destruction of the capsule of the shoulder-joint may occur without any change in the articular cartilages is exemplified very well by the shoulder-joints of a sailor shown in Figures 15 and 16. In both these joints the entire superior half of the capsule and the tendon of the biceps were destroyed and the internal surface of the acromial portion of the deltoid frayed. Yet the articular cartilages are well preserved and no bony or other changes at all suggestive of arthritis are present. But the best example of early functional destruction that I have so far observed is the capsular defect in the left hip-joint from a gardener, shown in Figure 17. This defect, which measured 2.2 cms., is contained in an otherwise wholly normal joint. It was covered by the broadest portion of the tendon of the ilio-psoas shown in Figure 18 and apparently was produced by contact of this portion of the capsule with the periphery of the femoral head which is slightly rough at the border of the cartilage in all normal bones.

Even if one recalls that the articular capsule of the hip-joint frequently contains a bursa in the region of this defect and hence is likely to be thinner, one cannot ignore the effect of friction. This is true even

(17) Anterior view of the left hip joint from a gardener aged 53. Note the extensive capsular defect, the thin margin of the latter and the fraying.



(18) The tendon of the ilio-psoas from the same case with the proximal extremity to the left. Note the slight fraying at the widest portion of the tendon.

if such a bursa, if present in this case, communicated with the joint cavity or even if an actual development defect was present in this capsule. This follows because the margin of the defect is worn to a very thin edge and frayed as shown even in the photograph. Moreover, since the tendon of the ileo-psoas also is worn and somewhat thinner in the area of contact with the femoral head, it is clear how large a rôle friction played in the production of such a capsular defect.

A second instance of a similar defect was observed in a seaman of 64 years. In this case, too, the margin of the defect showed undoubted evidences of wear and so did the internal surface of the tendon of the ilio-psoas. Yet the entire joint capsule and the articular surfaces of the bones appeared wholly normal.

Since I have not seen congenital defects in the capsules of hip-joints in a small series of foetuses near term and of infants which have come under my observation, I have been prompted to surmise that the defects occasionally said to occur in this capsule in adults and which are regarded as variations, possibly all are the result of erosion. Unfortunately, not sufficient material is at hand to enable me to determine this question at present, but if one considers the relation of the margin of the articular surface of the head of the femur to this portion of the capsule in movements of extension and flexion, and the rôle of the tendon of the ilio-psoas, one would be surprised if defects did not result from wear on internal surfaces of the capsule.

The severed tendon of the long head of the biceps in the cases of joint destruction no doubt receives a secondary attachment in the region of the lesser humeral tuberosity, not only because it normally is located upon the anterior portion of the head of the humerus but because of the trauma to which this region is subjected by friction from the acromion. Apparently this tendon may be worn in two places—near its scapular insertion from contact with the greater tuberosity, and in a region directly proximal to the lesser tuberosity, from contact with the acromion. However, the latter contact apparently never was sufficiently intimate in any of these cases to have resulted in division of the tendon in this region.

Until I had observed more specimens I was unable to satisfactorily explain the genesis of the secondary attachment of the tendon of the biceps. That the divided tendon attained its secondary attachment in the region of the lesser tuberosity in consequence of trauma and the inflammatory reaction invoked thereby, seemed very probable, but until the rôle played by the acromion in the production of traumata in

this region was known to me, I was at a loss to satisfactorily account for this secondary attachment of the tendon.

The tendon of the supraspinatus usually is divided only partially but may be markedly dislocated posteriorly together with the adjacent portion of the articular capsule. Rarely, however, it is completely divided and retracted quite independently of the divided portion of the capsule, becoming adherent to the surrounding structures and hence wholly useless. The tendon of the subscapularis also may be partly destroyed and displaced and even that of the infraspinatus may suffer a similar fate.

In several instances observed by me, the erosion of the humeral cartilage is very restricted, but in others the eroded areas are relatively large, although the corresponding area of contact with the glenoid lip may be relatively small. This is due to the fact that the humeral head glides back and forth over the eroded area on this lip. A similar relationship exists between the polished area on the greater tuberosity and that on the inferior surface of the acromion. The latter always is large and may be deeply worn, while the former is relatively small in most cases. In some cases there are two oblong eroded and highly polished osseous areas on the humeral head, which lie in a frontal plane. That nearest the greater tuberosity is produced by contact with the acromion. The one farther distant and lying roughly in the same line, is formed by contact with a small area on the superior glenoid margin. Since the bony polishing of the latter must be preceded by destruction of the resistant fibro-cartilage of the glenoid lip, one can form some conception of the duration of the friction.

Since the inferior surface of the acromion is covered only by periosteum and fibrous extensions from the coraco-acrominal and the acromio-clavicular ligaments and protected further only by the thin wall of the subacromial bursa and interposed areolar tissue, it and the co-apted region of the greater tuberosity naturally show evidences of erosion and polishing first. As reported in previous articles, this erosion may result in almost complete destruction of this tuberosity. Under these conditions there is sure to be considerable abrasion of the acromion and great destruction of the articular capsule and of the included ligaments, so that the acromio-clavicular communicates directly with the humero-scapular articulation.

Since the subdeltoid and subacromial bursae and almost the entire superior portion of the articular capsule and of the tendons of the supraspinatus, long head of the biceps, and partly also those of the

subscapularis and infraspinatus, may be destroyed and the acromio-clavicular articulation opened through wear, one is justified in speaking of partial destruction of the shoulder-joint in these cases, and it must be evident that the function of these shoulders must be greatly impaired. This is especially true in all cases in which the deltoid finally must act in place of the upper portion of the joint capsule. When its inner surface becomes frayed by wear from contact with the greater tuberosity the traumatic irritation well may cause spasm of the muscle. These shoulders also must lose greatly in stability because of such extensive destruction as here recorded. Abduction of the arm also must be greatly reduced in power, especially at the beginning of the movement, in cases of destruction of the tendon of the supraspinatus. Supination of the forearm should be greatly reduced in power, for a time at least, in all cases in which the tendon of the long head of the biceps fails to obtain a secondary attachment before division of it, for this would permit considerable relaxation of the outer belly of this muscle. Whether or not such an antecedent attachment is gained will depend, no doubt, partly upon the exact location of the destructive process,—that is, upon the particular use to which the arm is being put, and upon the reaction evoked in the traumatized tissues. Failure to secure such an antecedent attachment also would result in asymmetry in the contracted biceps.

That the destruction wrought in these shoulder-joints is not due to infectious processes is established conclusively by the fact that the inferior half of the capsule always is found to be entirely normal in thickness and appearance and also by the entire absence of adhesions outside the immediate area of the destruction. No matter how much erosion the external surface of the superior portions of the capsule showed, the internal surface invariably was smooth and normal in all respects and the same thing was true of the internal surface of the inferior portion of the capsule in cases of complete destruction of the superior half. Since the articular cartilages also were wholly normal, in many cases showing extensive destruction of the tendon and capsule, infectious processes can be excluded with certainty.

Such secondary changes as the attachment of the severed tendon of the biceps and the presence of small bony excrescences in the region of the humeral tuberosities, together with calcareous deposits in the divided, retracted capsule, easily could accompany such extensive traumatism, or arthritis may co-exist. However, since not a trace of hemorrhage or of coagulum was found in any of these—over a score—arms, any sec-

ondary infectious process which may have been present must of necessity have remained non-suppurative and hence incapable of such extensive destructions.

Effusion, pain, and limitation of motion no doubt are present over a considerable period of years in all these shoulders and it does not take much imagination to surmise that they probably were regarded as rheumatic or arthritic. Since the traumatic destruction of the soft parts, even if gradual, was so extensive, one cannot doubt that non-infectious, inflammatory reactions must have been present and that, in this sense, arthritis really was present in these joints. Moreover, it does not seem improbable that some, if not many, of the cases of subdeltoid bursitis have their origin in irritation from use.

I am unable to say how long a period of time is needed for the destruction wrought in some of these arms, but decades, no doubt, were involved. I never have encountered them in early maturity, although I must add that it is but rarely that we obtain a body from these years. All the specimens observed came from cadavers beyond the fifth decade but this does not presuppose that these changes can be regarded as senile. They no doubt were produced during the most active years of life of these persons, and, in the absence of reparative processes, merely have persisted. However, in some cases these traumatic defects no doubt have been enlarged during advanced years, for some of these individuals were engaged at work in which neither skill nor speed were indispensable factors.

The long period of time involved in these destructions makes one wonder how many bottles of soap, or Sloan's liniment, St. Jacob's or Omega oil these individuals must have used while seeking relief from what they themselves probably assumed was chronic rheumatism. The only relief from these things lies, to be sure, in a change of occupation. Lessened activity or a rest may bring some relief, but neither of them nor a surgical operation can stop the destruction. From the evidence presented here and elsewhere it seems to me that we must give these destructions larger consideration, for it seems undoubted that things which have been assumed to be pathogenic in cause are partly or even wholly the incidental effects of use, or better, of overuse.

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BONE SARCOMA.

BY JAMES W. GIBBON, B. S., M. D., CHARLOTTE, N. C.

It is now more or less generally recognized that there is much variation in the clinical manifestations and relative malignancy of sarcoma involving the bones, and this fact finds rational basis in the pathological diversity of these tumors. Because of this difference in the relative maligancy of types of sarcoma, the problem is very often not so much one of treatment as of diagnosis of the type of tumor with which one is dealing, if proper treatment is to be carried out. The malignancy varies from the rapidly growing, extremely fatal round-cell types to the so-called benign giant-cell or epulis type, with the fibro-sarcoma, myxo-sarcoma, and osteo-sarcoma as intermediary forms. The first is hopeless in spite of any method of treatment in 92 to 96 per cent. of the cases, while the least malignant, giant-cell type, is amenable to cure following so simple an operation as curettage, or at the most, a local resection of the bone. The giant-cell sarcoma never gives rise to metastases, is never fatal, and so benign in its clinical manifestations that some observers do not classify it as a sarcoma at all, but prefer the more descriptive terms of Giant-Cell Tumor (Bloodgood), or Chronic Hemorrhagic Osteomyelitis (Barrie). In Ewing's "Neoplastic Diseases" this lesion is classified among the sarcomata. Apparently the actual pathological position then of the giant-cell sarcoma has not been definitely determined, but the distinguishing feature on which all agree is its relative benignancy, and response to conservative treatment. Occurring in the localities of the rapidly growing, malignant sarcomas, the giant-cell tumor must at all times be differentiated from these, if radical operations for a comparatively benign lesion are to be avoided. Diagnosis, therefore, particularly of this tumor, becomes the great problem. In cases where there is any doubt, an exploratory incision should be made in order to allow a study of the gross form and preparation of microscopic sections of the tumor. The advantages of an exploratory incision for diagnostic purposes are greater than the disadvantages. No direct harm has been found to come from its use, and it may be the means of saving a limb. Even following a method so exact, the diagnosis may remain very obscure in certain cases, and pathologists may

completely differ in regard to the interpretation of the sections, so that, while we do attempt to make a precise, clean-cut diagnosis, there are occasions when this may be extremely difficult or even impossible. As remarked by Ewing, "There is considerable variation in the rate of growth and bone absorption by benign giant-cell sarcoma. As the spindle cells of the stroma become more active and abundant, the giant-cells diminish, the tumor shows less resemblance to granulation tissue, but becomes firmer and like spindle-cell sarcoma. Such growths recur locally, and may destroy bone and infiltrate the soft parts, but I have never known them to yield metastases." (Neoplastic Diseases). The case here reported may possibly exemplify some of the difficulties of diagnosis.

CASE REPORT.

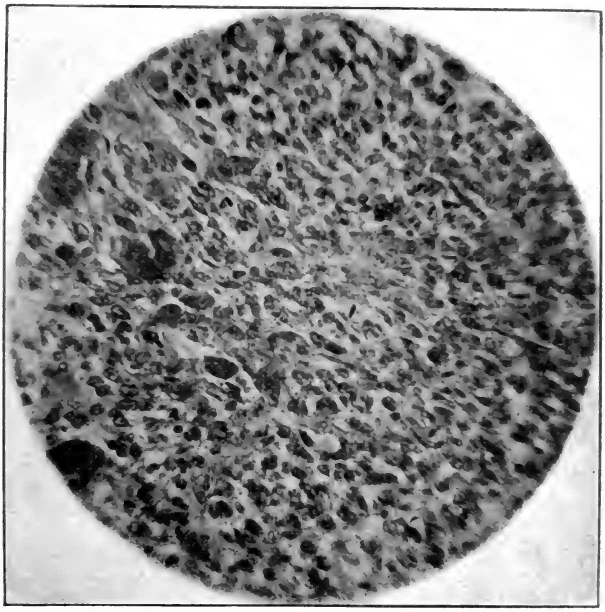
A white male, aged 16 years, complained of pain and swelling just above the right knee, and a limp. The onset was in March, 1921, with pain in and above the knee. There was no previous history of trauma, or symptoms referable to this extremity. This pain at first was very mild, and after two days of rest passed away. A soreness remained in the region, however, and thereafter he limped on walking. About the middle of June, pain again became a symptom, much more severe in character, and gradually becoming worse. The limp also became more exaggerated. The swelling was thought to have started about this time. The pain seemed much worse at night, and kept him awake. On August the first he presented himself for treatment.

On physical examination there were no features worth noting except the local condition. He was a well nourished boy, with a normal pulse and temperature. Local examination showed, above and to the outer side of the right knee joint, a globular swelling. The skin overlying it was blanched, not hot, and contained no enlarged veins. On palpation there was slight tenderness over the tumor, and a sense of softness. There was a small quantity of fluid in the knee joint, but no limitation of joint motion: There was no atrophy of the muscles above or below.

The urine examination was negative, no mention being made of Bence-Jones albumen. The blood Wassermann was negative, the leucocytes were 8,300, and the hemoglobin was 85 per cent. X-ray examination of the lower end of the right femur showed a sharply-defined lesion in the medulla of the diaphysis. There was almost complete destruction

of the compact bone, on lateral aspect the bony shell was apparently broken through, and no expansion of the bone was to be detected. In the periosteum an ossifying periostitis was visible. The epiphyseal cartilage was intact, and the epiphysis not invaded.

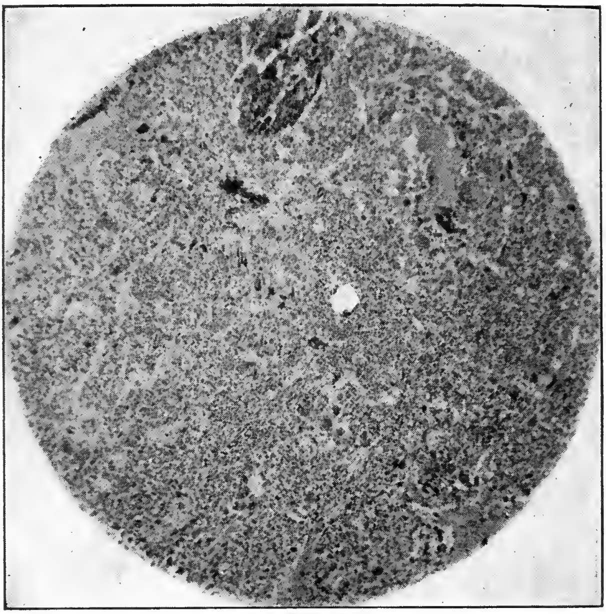
A positive diagnosis was made at this time, and on August the second, the lesion in the bone was explored. The cavity occupying the lower end of the femur was large, and filled with soft, dark red, hemorrhagic granulation-like material. The shell of bone was very thin, and to the outer side it had been broken through, and the same hemorrhagic material was infiltrating the soft parts. The epiphysis was not involved and the joint was not broken into. The periosteum was thickened and producing new bone. A gross diagnosis of Giant-Cell Sarcoma was



made, the bone cavity thoroughly curetted, all visible tumor removed from the soft parts, and the incision closed without drainage. A good deal of hemorrhage attended this procedure. The patient made a good recovery, and was discharged on crutches from the hospital on the tenth day, but was to return at regular intervals for observation.

Microscopical examination of the tissue removed showed some little difference in the giant-cell content in different areas. In all sections examined the tissue was seen to consist of closely packed cells lying in a thin, sparse stroma. These cells varied much in size and shape—some were round and some were spindled-shaped. Many mitotic figures could be seen. Between the cells large blood spaces were present, and contained blood. These were apparently large blood-vessels with thin walls, or walls formed only by the tumor cells. In one section as many as 8 to 12 giant-cells of the foreign body type could be seen in one high power field. In other sections these forms were less numerous, but present. There was a difference of opinion regarding the diagnosis from these sections, so some of the tissue was sent to Dr. Bloodgood, in Baltimore, and some to Dr. Crawford, in Philadelphia.

On August 20th, before a report had been obtained from either of these pathologists, the patient came back complaining of a return of severe pain. On examination it was evident that the tumor had re-



curred locally, and was infiltrating the soft parts on the inner side of the knee, where there was a considerable swelling. That this was then a rapidly growing sarcoma clinically seemed to be a just conclusion, and amputation was advised. The parents, however, refused this, and again all of the tumor tissue possible was removed, and the area cauterized with carbolic acid followed by alcohol. The recurrence at operation did seem to be confined to the soft parts, there being no extension up the bone, and no extension into the epiphysis, or invasion of the joint. A great deal of hemorrhage also attended this operation. On September the 14th, the leg was amputated in the upper third of the thigh, a local recurrence having again occurred at about the end of three weeks. X-ray plates of the thorax at this time showed no metastases. Healing of the wound and convalescence was then rapid and the patient was discharged on September the 25th. I have seen the patient several times since. He has gained weight and strength rapidly and is now perfectly well.

The report of Dr. Bloodgood was this: "Although there are some giant-cells there are not many. The tumor is composed chiefly of large round cells of the sarcoma type, some very large cells, some few spindle. It impresses me as a large round-cell sarcoma. Here and there are spicules of bone undergoing destruction. Many large blood-vessels

are present.'' Of the gross specimen he remarks: ''Your description of the gross tumor is that of the giant cell, but there is a sarcoma, fortunately rare, which resembles the giant-cell tumor in the gross, and I fear your tumor belongs to the sarcoma group.'' Dr. Crawford considered the specimen a giant-cell sarcoma.

The interesting features of this case are: the boy is 16 years old, a very rare age for central sarcoma (Bloodgood); he is now well following amputation almost twelve months after the symptom of onset, and six months after the amputation; the promptness of local recurrences in the soft parts; the marked bone destruction without expansion, and the production of new bone from the periosteum; the resemblance of the gross specimen to the benign giant-cell tumors; and the difference of opinion in regard to the sections. If this is a type of malignant sarcoma, it is of still greater interest because of its resemblance in the gross to the benign-cell sarcoma or giant-cell tumor.

OSTEOMA OF THE CERVICAL SPINE.

BY MELVIN S. HENDERSON, M.D., ROCHESTER, MINN.

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Case A375531. H. O., a boy, aged ten years, was first seen in the Mayo Clinic, October 21, 1921. The boy's mother gave a clear and concise history of his present illness. September 9, 1921, he complained of a dull ache in the right posterior part of the neck, aggravated particularly by sudden or jerky motions. After three days the pain was so continuous and severe that he was forced to stop school. About this time, slight swelling and tenderness in the region complained of was noted. His temperature varied from 99 to 101. Movement of the neck was greatly restricted and forced movement caused excruciating pain. At the end of a week, as the pain continued, the boy was taken to a hospital and an incision made into the swelling, but no pus was obtained. The surgeon confessed that he was unable to diagnose the condition, but thought it might be deep cellulitis. During the next two weeks the condition was even more aggravated and the swelling increased and extended to the right submaxillary region. Another exploratory incision was made by the same surgeon, and a hard tumor, not clearly outlined, about 4 or 5 cm. in diameter, was encountered, and believed to be in the deep cervical fascia. Specimens removed for examination were diagnosed as nonmalignant fibrous tissue with occasional islands of bone. The swelling did not subside, and the patient continued to suffer greatly from pain and loss of sleep and appetite. He had lost fourteen pounds in weight. Gradually, the pain became less severe, but continued to be persistent and worrisome.

Examination, October 29, 1921, revealed a boy of good physique, but the effects of his suffering were definite. He held his head forward so that his chin was practically on his breast, and in order to look ahead it was necessary for him to bend his knees and throw his spine back of the center of gravity. Examinations of the heart, lungs, kidneys and blood were negative. A thick, hard swelling involved the right upper cervical muscles and extended forward to the right submaxillary region.

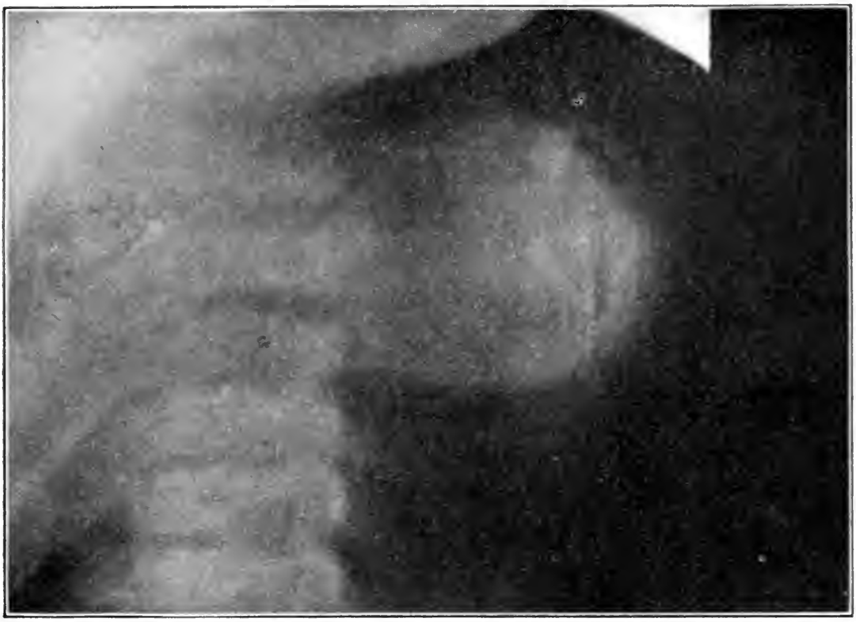


FIG. 1.—(A375531.)—Osteoma of the cervical spine.

A slightly purulent discharge drained from the incision, which was red and inflamed. A globular tumor was detected on palpation, and this finding was substantiated by the roentgen ray, which showed a circular, bony tumor about 5 cm. in diameter (Fig. 1). It seemingly arose from the right side of the third cervical spinous process or, possibly, from the articulating process. A provisional diagnosis of osteochondroma was made.

Tonics were prescribed and the boy was encouraged to go around out of doors. He had been in bed nearly seven weeks and we wished to increase his strength and heal the wound before removing the tumor. The wound closed in a short time and the boy's physical condition improved rapidly, but we waited for the inflammatory condition of the soft parts, which still extended well to the right submaxillary region, to subside, for the bony element of the tumor to harden, and for the tumor itself to become more defined before operating. With the disappearance of the soreness the tumor became more readily palpable and distinct, and the boy could raise his head more easily.

December 10, we considered the tumor to be "ripe," and operation was performed. An incision was made directly over the process, the

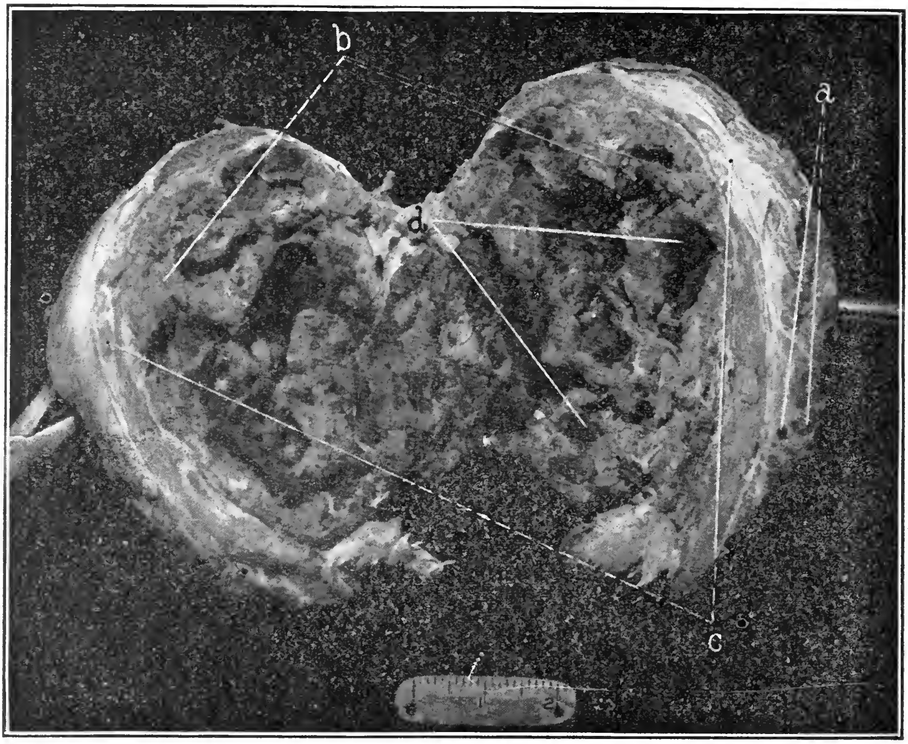


FIG. 2.—Section of the osteoma shown in Figure 1. a, muscle bundles; b, bone; c, capsule of tumor; and d, areas of hemorrhage.

muscles were separated, the gloved finger was introduced, and a circular tumor about 5 cm. in diameter was outlined. It was attached to the spinous and lateral processes of the third cervical vertebra on the right side. The muscles were stripped from around it by dissection with curved scissors. The wound was closed without drainage. Dr. A. C. Broders examined the tumor, microscopically, and reported that the specimen was a globular osteoma about 6 cm. in diameter, and was fairly encapsulated. On opening the tumor (Fig. 2) a fairly dense fibrous capsule was encountered, with trabeculae running into the surrounding muscle tissue. The interior of the tumor was made up of bone and fibrous tissue, the bone constituting a trabeculated framework. Scattered through the trabeculated areas were blood clots. Microscopic sections (Fig. 3) showed merely bone and fibrous tissue, with a few areas of leukocytic infiltration. No cartilage cells were to be seen. Some osteoblasts could be made out. Figure 4 shows the cervical spine after the operation.

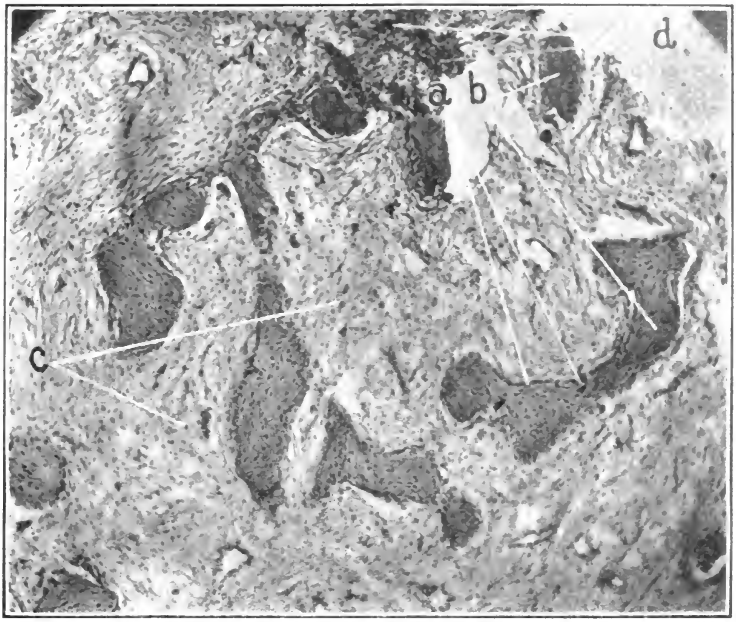


FIG. 3.—Photomicrograph of tumor (x 50): a, osteoblasts; b, bone; c, fibrous tissue, and d, leukocytic infiltration.

FIG. 4.—Cervical spine after removal of osteoma.

The patient's convalescence was uneventful and he was discharged December 20. A letter received, February 11, says that he had greatly improved although his neck was still stiff. He was taking exercises to correct this. Removal of the tonsils has been advised.

COMMENT.

The site of the tumor and the mode of onset are unusual. Bland-Sutton, in his book on tumors, mentions an osteoma that grew from the posterior surface of the odontoid process of the axis and caused death by pressing on the spinal cord. The case herein reported is the only osteoma of the cervical spine that has been recorded in the Mayo Clinic. The tumor was first manifested by severe pain, fever, and general malaise. Early exploration elsewhere was negative, but a secondary exploration two weeks later proved the presence of a tumor, and the pathologic report at that time was fibrous tissue and bone. Although our clinical diagnosis had been osteochondroma, on examining the tumor we could find only blood clots, fibrous tissue, and bone. The diagnosis was, therefore, changed to osteoma. Bone may form with or without cartilage as an intermediary stage, and in this specimen we could find no cartilage. The etiologic factor in the disease was clearly an infectious process, but bacteriologic studies were not made, because infection, or at least drainage of pus, had followed the second operation, and any observations on the type of bacteria would have been worthless. Whatever the type of bacteria, it in some way caused proliferation and growth of bone. We were unable to determine whether the tumor had its origin from the spinous process of the third cervical vertebra or whether it started in the deep structures of the neck and later became attached to the spinous and lateral processes of the vertebra. It is my opinion that it started in the muscle and fascia, and as it grew larger became attached to the bony normal structures beneath.

THE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP AS PRACTISED BY PROFESSOR DENUCÉ AT BORDEAUX, FRANCE.*

BY Z. B. ADAMS, BOSTON, MASS.

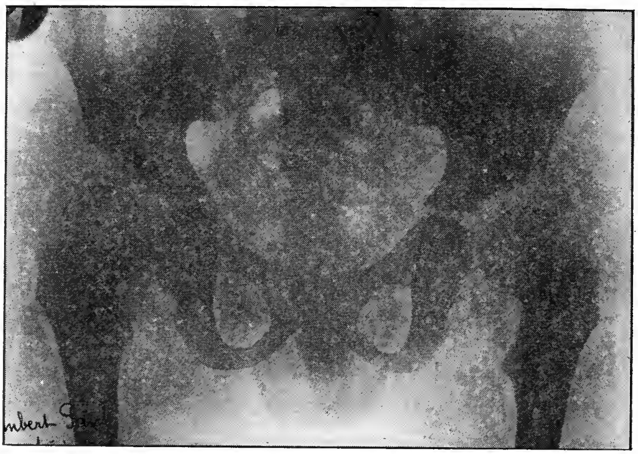
Two years ago, at Toronto, I read a paper before this Association, in which I showed that the end-results of our treatment of congenital dislocation of the hip at the Massachusetts General Hospital Clinic were functionally, as well as anatomically, far from what could be desired and far from perfect. You all know the subsequent circumstances:—Dr. Galloway's paper, advocating open operation on all congenital dislocations, and last year the work of the Commission on Congenital Dislocation of the Hip, in which the end-results of the treatment at the larger clinics in Cleveland, Rochester (Minnesota), Rochester (New York), the New York Orthopædic Hospital, Johns Hopkins Hospital, the Boston Children's Hospital, and the Massachusetts General Hospital were studied. It then became apparent that our end-results were neither functionally nor anatomically perfect.

In view of these facts, I was interested by a thesis written by a young man named Dr. Edouard Papin, of Bordeaux, describing the treatment of congenital dislocation of the hip, as practiced by Professor Maurice Denucé, of Bordeaux, France. Having read this thesis, I was interested enough to go last summer to Bordeaux, in order to report to this Association my impressions of this treatment of Professor Denucé and of his end-results—anatomically and functionally.

Professor Denucé—whose name you have seen on the cover of the *Revue d'Orthopédie,* as one of its editors—is a surgeon seventy-odd years old; a rather frail man, but a student of surgery for many years. He is the Professor of Surgery of Children at the University of Bordeaux, and he is the author of many articles and theses—one being a thorough study of spina bifida. At the outbreak of the war, when he was sixty-five years old, he found himself called upon to take care of all the surgical cases at the Children's Hospital in Bordeaux—an institution one hundred and fifty years old. Since that time, he has reduced over nine hundred luxations or sub-luxations of the hip, with but few failures. The staff managing these cases consists of Professor

*Presented at the meeting of the American Orthopedic Association, May, 1922.

Denucé and two house students—assisted by an old French Sister of Charity nurse, some sixty-odd years old. The reductions are all done manually by Professor Denucé's very ingenious method. It is not very unlike the method of Dr. John Ridlon, but it is not the same, as the reduction is preceded by a manual stretching of the adductor muscles, and of this Dr. Ridlon does not approve.



Paul Gombert.—Double; reduced at four years, April 25, 1918. August 10, 1921, perfect function.

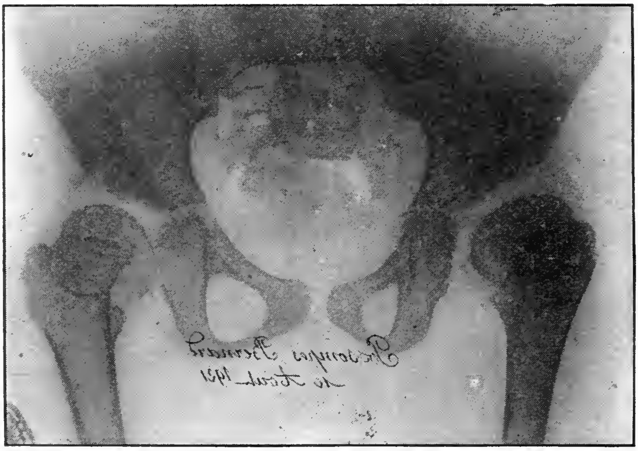
Reiné Rochereau.—Single; reduced at six and one-half years, August 14, 1917. August 10, 1921, perfect function.

This stretching is done by gentle stroking of the adductors with the soft part of the palm of the operator's hand—beginning at the pelvis, and stroking downward in the longitudinal axis of the thigh, the skin having been covered with powder. I may say here that, in Professor Denucé's reduction and treatment, he lays great stress upon the point that no violence or force is to be used. As the adductors are stretched,

SUZANNE DIVIES.—Double; reduced at 15 months, April 16, 1916. August 10, 1921, perfect function.

PAUL THOMAS.—Single; reduced at three years, March 14, 1918. July 28, 1921, perfect function.

the thigh is brought up to right-angle flexion and full abduction. Having stretched the adductors so that the thigh will lie upon the table at right angles with the trunk—the patient in the decubitus position—the attempt at reduction is then made. This is done by the operator standing on the side of the patient on which is the dislocated hip to be reduced; the thigh is flexed on the trunk,—the knee being carried across



Bernard Possompes.—Double; reduced at five and one-half years, May 16, 1918. August 10, 1921, little limitation of abduction at 90 per cent. of flexion; flattening of the left buttock; otherwise good.

Marie Jeanne Ricarrère.—Single; reduced at 6 years, May 17, 1917. August 10, 1921, perfect function.

in the direction of the axilla of the opposite side, and the thigh firmly pressed down on the anterior body wall. The knee is held in this position, a slight push being made in the longitudinal axis of the thigh. The fingers of the operator's other hand are placed under and around the head, neck, and trochanter, lifting up, and pressing the muscles in between the head and side of the pelvis; then circumduction is begun.

DENISE LEBBÉ.—Reduced at one year in 1914. August 10, 1921, perfect function.

ARLETTE LACOMBE.—Double; reduced at three years, March 14, 1918. August 10, 1921, perfect function.

The knee is carried across the body trunk to its own side, and then downward to the surface of the table, and then abducted,—all of this time the fingers behind the head are held firmly in place and lifting; the circumduction is slowly continued until the thigh is brought to a right angle with the body trunk and lying on the surface of the table—the assistant holding down the opposite side of the pelvis by a hand

Valentine Pigneau.—Double; reduced at 18 months, January 9, 1917. August 10, 1921, perfect function.

Marcelle Crescos.—Double; reduced at two years, October, 1917. August 10, 1921, perfect function.

over the crest and anterior spine. The head is felt to *slowly* come forward and lodge in the acetabulum. As some of the doctors have suggested, it "oozes" in. At times, the shock is very slight.

After the reduction, the hip is tested for stability,—the leg being drawn straight down; the point where the head jumps out is noted, and again the knee is brought up by being adducted at ninety degrees flex-

CHARLOTTE LABORDE-FALLOT.—Double; reduced at two years, June 12, 1919. August 10, 1921, perfect function.

LUCIENNE RODIER.—Double; reduced at two years, February 24, 1917. July 28, 1921, perfect function.

ion, and the point at which the hip jumps out of the socket is noted. Should the hip be very unstable, the plaster is applied with the thigh in a modified Wernsdorff position,—that is, ninety degrees of abduction and one hundred and ten degrees of flexion; but the ordinary case, with fair stability, is put up in what Professor Denucé calls "ninety-ninety," that is, ninety degrees of flexion and ninety degrees of ab-

GEORGETTE BOUNIORD.—Single; reduced at four years, July 15, 1920. August 10, 1921, not finished; still in salt baths; roof of socket forming; stable and good when reduced.

CLAUDETTE PORTENS.—Single; reduced at two years, March 27, 1919. August 10, 1921, perfect function.

duction. Over a single layer of bandage made of eiderdown cloth, and applied with the nap in, one layer of plaster bandage is put, and then a sheet of plaster of Paris, made from six thicknesses of crinoline, is moulded around the child, and this is fitted down and held in place by another layer of plaster bandage. The plaster extends from the nipple line to just above the ankle.

GERMAINE PENOUIL.—Double; reduced at two and one-half years, July 27, 1920. August 10, 1921, after 7 months of post-operative treatment.

ROBERT FRITZ.—Double; reduced at three and one-half years, in 1918. August 10, 1921, perfect function.

Should he fail in his first attempt to reduce the hip, he does not repeat his trial, but puts the child up in traction for three weeks—drawing the head down, and then in a second attempt to reduce, he repeats the steps as before described.

The hip being reduced and put in plaster, Professor Denucé sends the child home, often immediately after the operation, allowing simply

LUCETTE PRUNGNAUD.—Single; reduced at six and one-half years, June 20, 1916. August 10, 1921, little laxity, little clicking, no limp.

VICTORIA SUZINI.—Single; reduced at six and one-half years, June 27, 1918. August 10. 1921, little limp on left; 1 cm. atrophy on left; little increase in outward rotation on left; hyperextension little lax on left.

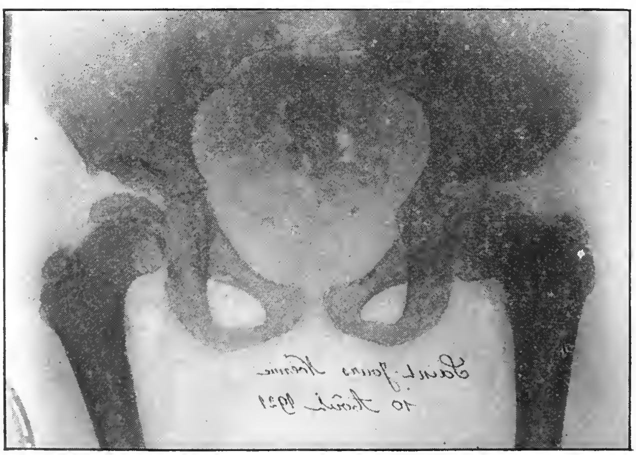
time for the plaster to set. There is no trauma, no ecchymosis, no danger, and no pain afterwards—providing the child is young. He sees the case again at the end of three months. The old Sister gives the parents directions about the care of the child in the plaster,—not to allow it to get the cast wet with urine, and to keep the child not in bed, but on the top of a flat, firmly padded table.

ELIANE BOUCHET.—Single; reduced at three and one-half years, April 6, 1916. August, 1921, 1 cm. of atrophy of thigh; perfect function.

YVONNE DUPEYRON.—Reduced at 4 years, May 9, 1919. August, 1921, perfect function; slight atrophy of glutaeus.

At the end of three months, if the child has grown rapidly, and on palpation the head of the femur is felt being pushed forward into the groin, the plaster is cut off above the knee, and the lower end of the femur and leg allowed to go free. The plaster is left intact, excepting for this change, and if the child has not grown too fast, the plaster is simply patched if soft, and allowed to remain in its entirety. At the

Marthe Fourtage.—Reduced at two and one-half years, September 19, 1916. August 10, 1921, perfect function; slight laxity.



Noémie Saint-Jours.—Double; reduced at 18 mos., August 31, 1915. Relapsed on left after 2 years; replaced; arthritis on left in 1918; treated by rest and plaster spica. August 10, 1921, perfect function.

end of six months—and Professor Denucé does not vary the time with variations in age—the plaster is bivalved into an anterior and a posterior valve, the child being bandaged into the posterior plaster, and the anterior plaster being thrown away. The parents are instructed by the old Sister in Professor Denucé's method of after-care.

YVONNE ROQUIE.—Double; reduced at four years. October 3, 1918. August 10, 1921, perfect function.

MARIE MERILLEAU.—Single; reduced at 18 months. August 22, 1918. August 10, 1921, perfect function.

Each day the child has an hour of hot sand, in a cloth bag, applied at the knee and over the front of the hip while lying in the plaster. After this heating, the child is coached to move its legs, to lift the femur forward, to straighten the knee, and to rock the lower leg. General heliotherapy is also given, beginning with periods of five minutes, and increasing the period daily five minutes until the child has one and one-half hours of sunning each day. At the end of two or three weeks, the posterior plaster is removed, and the child lies on the top of the firmly padded table.

The exercises are given twice a day, for a period of one-half hour each. No passive motion to the hip, but active motion; motion in abduction as well as adduction, and motion in rotation, flexion, and extension. The child is turned on its face, and taught to contract the gluteal muscles on both sides, and to rotate the thigh inward and outward while lying on its face, and to lift the thigh and hips off the table, and to swing the hips from side to side when lying prone on the table.

When the exercises have continued for three or four weeks, the child is given baths in a strong salt solution. This bath consists of a deep tank filled with salt and water, in the proportion of one and one-half kilos of salt to ten litres of water. The water is neck-deep in the tank, and there is space enough for the child to kick its legs. The child is carefully lifted from the table—the hip being gently supported—and is put into this tank. The water being more buoyant than the water in the Great Salt Lake, the child bobs up and down, the feet never touching the bottom of the tank. The child is left in this bath for from ten to thirty minutes, beginning with ten and increasing to thirty. The water is 70° Fahrenheit, or thereabouts. The baths are given daily for thirty baths, and then every other day for thirty more baths, and then there is an interval of a month, and then the course of three times a week is repeated for thirty more baths. The child is taken from the bath, and is wrapped in a warm blanket. The heliotherapy and exercises are continued, and the local heat with the sand-bag, and all through the child is made to keep the ability to abduct. In the cases of double hip, the patient sits for thirty minutes with the legs straight out, rotating in this position, while sitting straight up on the table,—the "split" act of the ballet dancer.

No weight-bearing is permitted on these hips until the center of ossification of the upper epiphysis of the femur is seen to have begun to increase in size markedly, and the head to shape itself, which is usually

three to five months after the removal of the plaster. Then walking is begun, with very short intervals of standing, and gradually increasing the time the child is allowed on its feet. The exercises, local heat, and baths are continued for many months; cases of thirty-one months of exercise are recorded. The function is almost perfect in all of the cases.

Several x-rays of the end-results of these cases are shown in this article. Unless otherwise stated, the method of reduction used is Professor Denucé's.

TENDON TRANSPLANTATION FOR MUSCULOSPIRAL (RADIAL) NERVE INJURY.

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One of the real surgical improvements resulting from the experience of the Great War was the more practical application of tendon transference to peripheral nerve injuries of the upper extremity, more particularly to musculospiral paralysis. It is now generally taught that such operations are to be performed only in cases with extensive nerve destruction which do not permit of end-to-end suture of the nerve or where suture has been done without return of function after a period of eighteen months or longer, or where for other reasons there is little or no hope of being able to restore power to the paralyzed muscles.

Some have advised using free nerve or other grafts to bridge extensive gaps and waiting for nerve recovery, but such procedures have usually been unsuccessful, even though slight return of power in some of the muscles may occur. I saw one case with partial recovery two years after such a nerve graft had been done, but it was so slight as to be of no practical value. On the other hand, I heard Sir Harold Stiles, of Edinburgh, say that he believed that tendon transference should be done without further delay in cases where the nerve could not be sutured under the most perfect conditions for recovery, as in extensive destruction and scarring of the soft parts, where end-to-end suture can be done only with considerable tension or where paralysis of long duration has resulted in extreme muscle atrophy. He contended that even if the nerve regenerated and power in the muscles returned later on that no harm resulted from the tendon operation.

The operation considered here is applicable, of course, only when the muscles supplied by the median and ulnar nerves are functionating normally. It is also essential that stiff joints and contractures of wrist and fingers be relieved before operation and that the soft tissues be free from scars and edema and otherwise in a state of good nutrition. Where the wound is near the elbow care should be taken to determine whether the muscular branches to supinator longus and extensors of wrist are

involved, as these are given off some distance above the joint. If the wrist extensors are acting it is necessary only to take care of the paralyzed thumb and finger extensors. Or, if only the supinator longus is intact, this muscle may be used to supply finger or thumb or wrist extension. I have not used this muscle for this purpose, though I have employed it in median paralysis with good result.

Sir Robert Jones and Major McMurray, of Liverpool, were the first to perfect and popularize a really successful operation of this kind. I had the pleasure of seeing some of their earlier cases while on duty at the Alder Hey hospital in the summer of 1917. Their technic and after-results soon convinced us that they had accomplished something which was a great boon to certain otherwise hopeless cases. In fact it seemed more successful than most of the tendon operations which we had all previously done for paralysis in the leg and foot in old poliomyelitis cases. This impression was later borne out in my own experience and in that of many of the others there at that time. The explanation of this is that in the lower extremity there is the all-important factor of weight-bearing and the necessary stability to be attained. We have often expected too much in this respect from transplanted muscles in limbs with more or less loss of power to begin with and with additional loss as a result of the transference, though the remaining power be ever so well balanced by the operation. Moreover, muscle reëducation seems to be more easily accomplished in the upper than in the lower extremity.

It is true that in the hand we have what may appear a more difficult problem, namely, the fine movements of the thumb and fingers. This difficulty I have found to be more apparent than real so far as musculospiral paralysis is concerned. When we analyze the situation, it is found that the important functions which are lost in these cases are, in order of their importance, extension of the wrist, abduction and extension of the thumb with its metacarpal, and extension of the proximal phalanges of the fingers. While the supinators longus and brevis are paralyzed, supination of the forearm and hand is accomplished quite well by the biceps unaided. It will be remembered that all the small muscles of the hand are supplied by the ulnar and median nerves. Another important fact often overlooked is that extension of the second and third phalanges of the fingers is performed individually and collectively by the lumbricales and interossei independently of the action of the extensor communis digitorum. This fact allows us to transfer a single tendon, the flexor carpi ulnaris, into all the long finger extensors without

seriously interfering with individual action of these four fingers. It is surprising what good individual function results in these fingers when all the long extensor tendons are tied to one transplanted tendon.

This is an important difference in the technic which I have used in the last seven or eight cases from that of Jones and McMurray whom I followed in my first cases. They attach the flexor carpi ulnaris to the long extensors of the middle, ring and little fingers only, and implant the flexor carpi radialis into the extensor indicis, extensor brevis pollicis and extensor ossis metacarpi pollicis, which, I am convinced, gives less perfect thumb function than when the flexor carpi radialis is attached to the three thumb extensors only, as in the operation to be described. McMurray justifies his omission of the extensor longus pollicis by the fact that the distal phalanx of the thumb can be extended by the action of the adductor transversus pollicis which sends a slip to the long extensor tendon. But this action on the distal phalanx is produced only when the thumb and its metacarpal are in adduction and palmar rotation. When they are in full abduction and extension it requires the action of the extensor longus pollicis to maintain extension of the distal phalanx. This fact can be easily demonstrated on the patient. Moreover, the extensor longus tendon has an important function in assisting in abduction and dorsal rotation of the thumb, an additional reason for joining it to the transplanted flexor carpi radialis. It is of the greatest importance to obtain full ability to abduct the first metacarpal and extend both phalanges of thumb and at the same time be able to perform dorsal or palmar rotation. And these movements should be independent of the index finger and not minimized by having the additional work and mechanical obstruction resulting from attaching the index tendon also to the flexor carpi radialis. The importance of these points is in getting a wide grasp. In fact, the wider the grasp between thumb and fingers the better the result, and much of this depends on the treatment of the thumb extensors.

Stiles, Danforth, and Baldwin put the palmaris longus into the three thumb extensors and the flexor carpi radialis into the extensor indicis. I had the pleasure of seeing some of the cases of these gentlemen at the Edinburgh War Hospital, and their results were quite satisfactory. However, their method is somewhat more complicated, involving more trauma, and showed no better results than from the one I shall describe. Moreover, the palmaris longus is absent in many patients and in others is too weak to be of use.

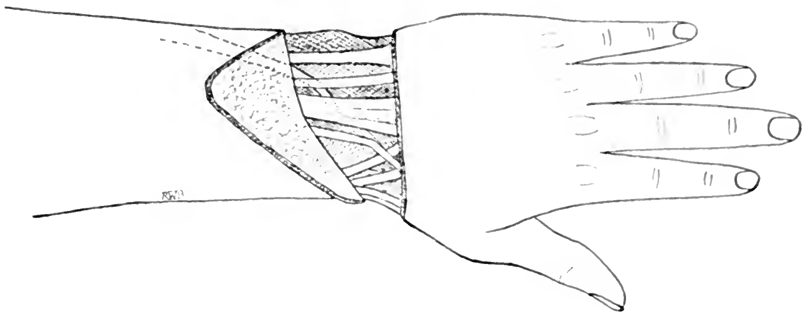

Fig. 1.—Showing exposure of tendons at the back of the wrist and the position of the flexor carpi ulnaris tendon after insertion into the finger extensors.

I wish to acknowledge my indebtedness to the authors of the first really successful operation of this kind. I hesitate to express opinions based on such a comparatively small number of cases, but the results have been so uniformly gratifying by the modified method which I have used that I take this opportunity of describing it in detail.

Two assistants are necessary, the whole duty of one of these being to carefully and continuously hold the wrist and fingers extended and the thumb abducted and extended during and after suture of the tendons until the special cock-up splint with thumb-piece is applied.

Three incisions are made: (1) one and one-half inches long over the radial border of the forearm at its middle, opposite the insertion of the pronator radii teres; (2) three-fourths of an inch long over tendon of flexor carpi radialis three to four inches above wrist; (3) starting on ulnar border of forearm, four inches above pisiform bone, passes straight down to the level of this bone, and turning at a right angle passes across dorsum of wrist to a point slightly beyond tendon of extensor ossis metacarpi pollicis just proximal to base of first metacarpal. This triangular skin flap is dissected up far enough to expose the finger extensors just proximal to the annular ligament, and the thumb extensors at the "snuff box" area over the carpus, avoiding injury to the radial nerve. These incisions give ample exposure with a minimum of dissection and trauma, as compared with the long U-shaped flap of the Jones-McMurray incision. In one case done by the latter method I saw a slight necrosis of the margin of the flap, which seems to me a real danger that can be easily avoided.

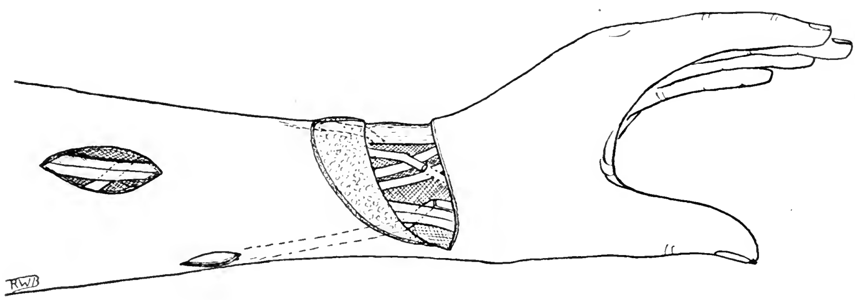

FIG. 2.—View of all three incisions from the radial aspect. Note arrangement of transplanted pronator radii teres and flexor carpi radialis, as described in text. Correct attitude of wrist, hand, fingers and thumb.

The short tendon of the pronator radii teres is now severed from its attachment to the outer surface of radius, having retracted the supinator longus forward. Buttonhole openings are made in the tendons of extensor carpi radialis longior and brevior as low down as possible to permit the severed tendon to be drawn through and sutured to each, after opposing surfaces of tendons are scarified to insure union. Fine silk is used and the exposed, ragged end of the tendon is clipped off flush with the receiving tendon and its raw surface buried with a suture. During and after suture the tendons should be under slight, equal tension with the wrist held in full hyperextension. Here, as elsewhere, the tendons should be handled carefully, avoiding traumatized or raw surfaces of tendons which might cause adhesions. It is important that both long and short extensors be used here so as to give better leverage for extending the wrist with less tendency to radial deviation of the hand than if only one were used.

Next the flexor carpi ulnaris tendon is exposed by sliding the skin slightly and is cut at its insertion, taking care to avoid the ulnar nerve and artery. The tendon is then freed upward as follows: Since muscular fibres are usually attached to within one-half to one inch of its distal end, these fibres are sheared off smoothly from the tendon up to a point two and a half inches above the wrist, leaving a perfectly clean tendon up to this point, and from there separating the muscle by blunt dissection in the line of its fibres obliquely to their attachment to the posterior border of the ulna about an inch higher up. The skin has not been dissected up this far on the dorsum of the forearm, so a tunnel is made subcutaneously from the highest point of the ulnar incision to the ex-

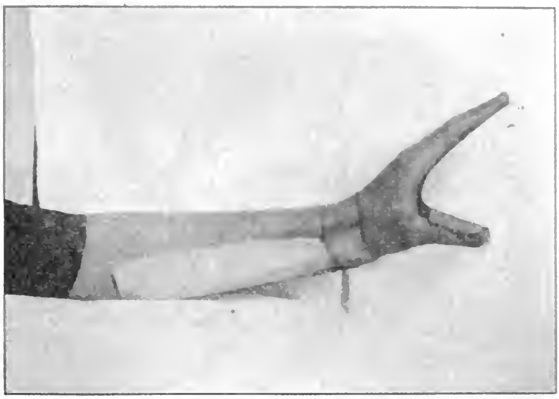

FIG. 3.—Hand on special long cock-up splint with thumb-piece, showing proper attitude of parts.

tensor tendons at the back of the wrist. The tendon and an inch or so of the muscle above are swung around to the back of the ulna and the tendon drawn through the tunnel, thus avoiding kinking or twisting and making the direction of muscle and tendon nearly a straight line from origin to new point of insertion. This procedure is simple if understood and insures good function of the transplanted muscle. The extensor minimi digiti and extensor communis digitorum tendons are exposed, by carefully incising and preserving the thin overlying fascia, then buttonholed obliquely from within outward and the transferred tendon drawn through and sutured to these four tendons in a similar manner to that previously described. It is not necessary to include the extensor indicis tendon. During and after suture all the tendons should be under slight and equal tension while the wrist and all four fingers are held fully extended. If the tension on the tendons is not equal it will be impossible to actively extend all the fingers fully. The fascia is then closed over the sutured tendons with fine catgut so as to prevent adhesions to the skin.

The tendon of the flexor carpi radialis is now exposed, by retracting the radial end of skin incision No. 3, and divided at its insertion. It is then hooked up through skin incision No. 2 and pulled out, then threaded through a subcutaneous tunnel to the styloid process of the radius. Incise and retract the fascia and expose the three extensor tendons of

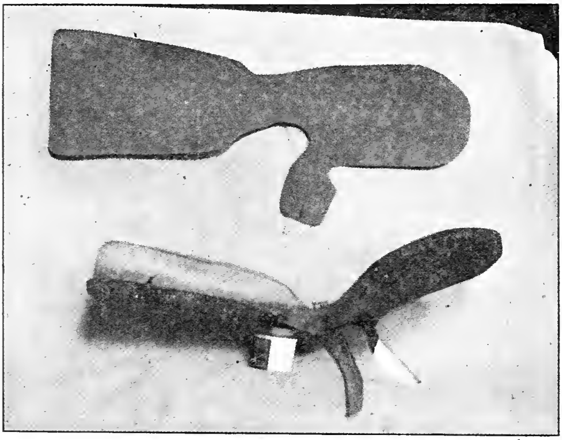

FIG. 4.—Pattern of special long cock-up splint with thumb-piece (above). Below is shown the finished splint. This is made of light, galvanized sheet metal, reinforced at the narrow wrist portion. A webbing strap with buckle at the ulnar border is riveted to the splint at its bend one inch distal to position of wrist joint.

the thumb opposite the carpus. Buttonhole the extensor ossis metacarpi pollicis and extensor brevis pollicis and draw the transferred tendon through. Sever the extensor longus pollicis tendon, slide the distal segment over alongside the extensor brevis pollicis and suture it end to end to the flexor carpi radialis. The two perforated tendons are fixed to the transferred tendon in the usual manner, after scarifying at proper points to insure union. Here again particular care is necessary to join the tendons under proper tension. It should be just enough to maintain the thumb and its metacarpal in full extension and abduction midway between palmar and dorsal rotation, and with the wrist extended. This position is carefully held until the splint is applied, which maintains it. The overlying fascia is closed with fine plain gut. All skin incisions are closed and iodined, light alcohol gauze dressings applied and the special long cock-up splint with thumb piece is applied, holding the wrist hyperextended, the fingers not quite fully extended and the thumb in position just described.

About a fortnight after operation the surgeon himself should remove the splint, carefully maintaining the same position, while the patient is first instructed and then told to make light voluntary contraction of the transplanted muscles. Proper resistance should be made by the

surgeon to prevent any flexion of the wrist, fingers or thumb during this effort, as it might loosen or stretch the sutured tendons. After each transplanted tendon is felt to tighten under the examining finger the splint is reapplied. This is repeated daily, gradually increasing the number and strength of the contractions. If at first it is impossible to get the patient to make the proper voluntary contraction the transferred muscles may be stimulated by a very mild faradic current.

Patients always take a keen interest in this muscle education. By the end of the fourth week the case can be safely turned over to a competent physical therapy assistant and the patient is told to make frequent voluntary contractions of the muscles while wearing the splint so as to improve muscle strength. The splint should be worn, except during supervised exercises once or twice daily, until about the tenth week, when it may be left off for increasing periods each day, regulated according to the strength shown in the given case. It has been surprising and gratifying to see how quickly these patients are able to reëducate the muscle impulses so that, for example, they do not have to stop and think about pronating the forearm and hand when extension of the wrist is wanted, etc.

At first it seemed questionable whether the pronator radii teres would be able to strongly extend the wrist after this operation. I still think this doubtful were it not for the assistance in this movement gotten through the action of the flexor carpi ulnaris on the finger extensors. This latter action is considerable and helps to replace the action of the paralyzed extensor carpi ulnaris, also thus helping to prevent radial deviation of the hand. At any rate, there is no doubt that satisfactory wrist extension is obtained by this technic, though it is evident that considerable power and resistance is required here when the opposing flexors are brought into action for grasping firmly.

No effort has been made to transfer tendon sheaths with the tendons, as has been strongly advised by some in all such work. In fact, the pronator radii teres and flexor carpi ulnaris have no sheath and there has been no serious trouble with adhesions in my experience.

Too much emphasis cannot be placed on the importance of obtaining free, active movements of the thumb, which are more complex than those of any other part of the hand and are very essential to good function. With the above operation properly executed one can obtain full active extension of both phalanges and the metacarpal combined with abduction or adduction and palmar or dorsal rotation,—in fact, practically complete function. This allows flexion of fingers while the

thumb is kept in the extended position, thus preventing the annoyance of having the thumb caught under the fingers when making a fist or grasping the handle of a hammer or golf stick or similar objects which are not simply to be caught between the tips of the fingers and thumb. With full finger extension this gives the widest possible grasp.

Success in this operation depends on many factors, the more important of which may be summed up as follows:

1. A thorough knowledge of anatomy and the individual and associated actions of all the muscles of the extremity.

2. Neat workmanship, perfect hemostasis, and a minimum of trauma of other tissues as well as tendons.

3. Suture of the different tendons under proper tension and in good alignment and covering sutured points with fascia.

4. Most thorough aseptic technic, as infection would damage if not altogether spoil the result.

5. Healthy tissues in the field of operation, free passive movements of all joints, and strong, active muscles supplied by median and ulnar nerves.

6. Use of a correct, specially made, long cock-up splint with thumb-piece (metal or moulded plaster) which will positively maintain the proper attitude of hand, fingers, and thumb during healing and after-treatment.

7. Thorough reëducation of muscles and physical therapy measures over a period of at least two or three months, remembering that the after-treatment is no less important than the operation itself.

As to results, naturally some cases have been better than others, even with the same operative technic. Experience is helpful. But in all of my own as well as in the patients of other operators mentioned as observed there was great improvement in function. I have seen no complete failures and none rendered worse in any respect by the operation. In fact, with an intelligent patient and a favorable condition of the tissues, one can be reasonably sure of getting a functional result closely approaching that of a normal hand.

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THE POST-OPERATIVE CARE OF FLEXION CONTRACTION OF THE HIP.

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Lovett[1], in a recent communication to the American Orthopedic Association, showed that during the third year of the treatment of infantile paralysis about one-third of the cases showed loss of muscle power. This loss was due chiefly to increasing deformity. Furthermore, the single deformity causing the largest percentage of loss in any segment was hip flexion contraction, which accounted for 80 per cent. of the loss in the upper leg where the loss could be traced to deformity. Hence, a safe and efficient means of treatment of this deformity is highly desirable.

Soutter[2] described an entirely satisfactory operation for this condition not only in infantile paralysis but wherever it exists. He advised the immediate placing of the patient in the hyperextended position in a plaster jacket-spica. This procedure has been followed at the Children's Hospital for a number of years. Certain unfortunate experiences occurred with this procedure, not only at the Children's Hospital but in the hands of others. Death has been reported in a very few cases; severe circulatory disturbance has occurred in at least two others, and shock so severe as to endanger life has occurred in a number of others.

The exact explanation of these phenomena is not known. In the cases with circulatory involvement there was a sudden complete blockage of circulation up to a very definite level in the lower leg. Relief was secured only by reducing the degree of extension. In one of these cases a secondary shut-down occurred demanding still further flexion. In each case the blockage came on several hours after the hip had been extended. It was felt that this was probably due to a vasoconstrictor influence on an already flattened vessel—the flattening having occurred as the result of stretching and extension.

In the cases of shock and death there was no apparent circulatory involvement of the leg and we are inclined to think that it may be due

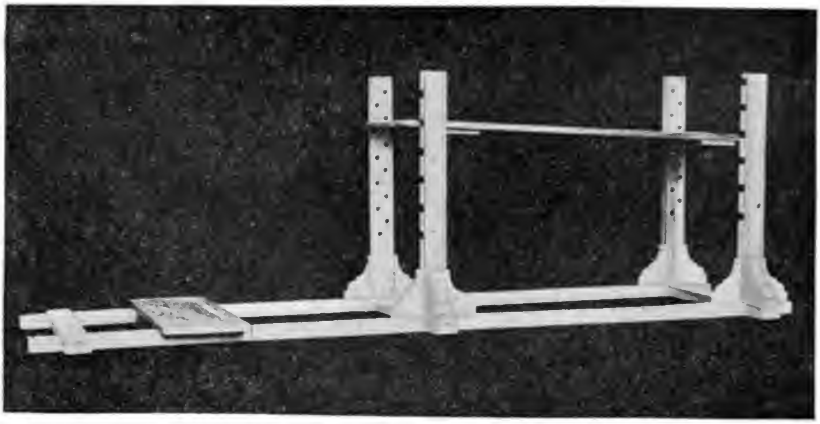

Fig. 1.

to the pain of stretching the contracted nerves or to the sudden painful lordosis of the lumbar spine resulting, possibly, from a slight contracture of the ilio-psoas muscle, but in no case at the Children's Hospital has it been necessary to loosen the ilio-psoas from its attachments.

These considerations led to the construction of a bed, which consists of a rather narrow frame which rests on the cross-bars of the bed. On this frame for a base there are erected four uprights—two at the head, and two at the middle. The uprights are notched to receive cross-bars of iron, and the distance from notch to notch is one inch. On the iron bars a cleated board is placed which is to act as a bed board for the patient's body. A narrow footboard is fitted with cleats so that it can be moved forward and backward on the foot of the frame. (See Fig. 1.)

With this apparatus one is able: (1) to get adequate fixation of the pelvis and body, by either a plaster jacket or a pelvic band and perineal and shoulder straps; (2) to permit gradual hyperextension by raising the bed board one or more notches a day; (3) to correct any adduction or abduction elements of the deformity by changing the position of the feet on the foot board from day to day; (4) to adjust the frame to any patient by means of the adjustable foot board. (See Fig. 2.) Such a frame can be constructed by any carpenter at a minimum cost.

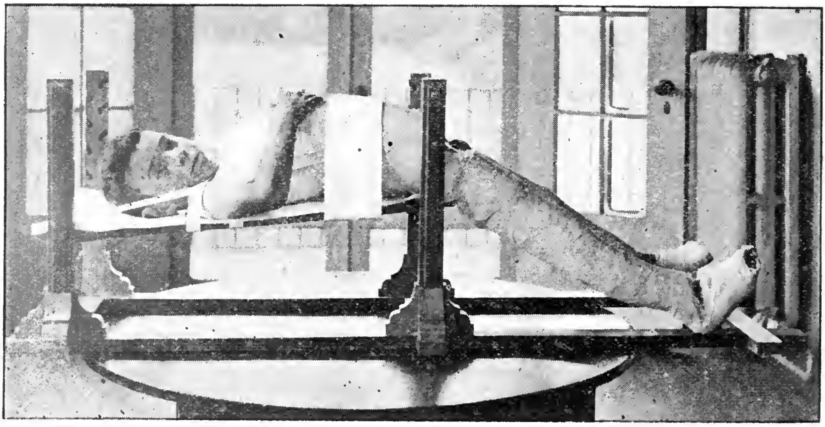

Fig. 2.

The after-care of these patients at the Children's Hospital now is as follows: the patient is put up in a gauze dressing at the close of the operation and permitted to lie with the knees flexed for ten days to two weeks. The wounds are then dressed and the leg and foot put up in plaster. The method of application of the jacket is of no small importance. The patient is placed either on a spica board or a hammock with his legs flexed until his back is flat. The jacket is applied and carefully moulded around the spines, trochanters and the pubis and sacrum. The child is now laid on the frame without a pillow under his shoulders, and the bed board is put in the lowest notch and the legs are put on a level with the body, or with the slightest hyperextension. The child is kept from slipping off the board with perineal straps, and is prevented from sitting up by means of shoulder straps. From day to day the height of the bed board is raised, the amount of raise being governed by the development of pain. The foot board is adjusted to the heels each time the board is raised. When the desired height is reached the child may be permitted to lie on the apparatus until the completion of treatment, or the legs and jacket may be joined together in the hyperextended position and the child transferred to an elevated Bradford frame. After six or eight weeks in full hyperextension the plaster is removed and one proceeds with the correction of any other deformities.

A person who has once suffered from a hip flexion contraction is likely to have a recurrence unless carefully watched. The recurrence

is usually due to a desire on the part of the patients to sit most of the time, or because the brace is too short and they try to sit on top of it. These patients should lie for several hours a day on the abdomen with the legs straight down from the pelvis, or else they should lie on the back with the pelvis supported on a couple of pillows. It is very important to keep the braces of the proper length.

Since the introduction of this method of handling these cases over a year and a half ago there have been no untoward results, pain and discomfort have been much less, and the bed care has not been made any more difficult.

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THE PAINFUL TRAUMATIC SHOULDER.

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PAIN in the shoulder region is an exceedingly common condition. It may come on insidiously without any very obvious cause or it may appear immediately after an injury. Of gradual onset are cases of tuberculous infection, of new growth, and of osteoarthritis. With these I do not propose to deal. I wish to consider more particularly cases where the onset is somewhat acute, and more especially those which follow an injury. My attention has been focused upon this matter from encountering, within a very short interval, a number of cases presenting symptoms and signs which, while varying in extent, were similar in the two points of localized tenderness and localized atrophy. So far as I am aware, the influence of minor injuries to the brachial plexus in shoulder-joint injuries has never been emphasized. The cases which form the background of this communication are explicable on the basis of such a lesion, and no other.

These cases form a logical series leading up to the fully established brachial palsy. Following textbook teaching, we are too apt to concentrate upon high lights only. Thus in examining shoulders we feel satisfied if the deltoid is apparently uninjured, and in brachial palsies we are accustomed to think of "upper arm types" of "lower arm types," and of these combining to form the complete palsy. We do not appreciate how comprehensive a term "brachial palsy" is. It includes all lesions from the slight atrophy of the infra-spinatus at one limit to the slight wasting of thenar and hypothenar eminences in cases of cervical rib, at the other limit. The transition is gradual, not abrupt, and such terms as "Erb's palsy" or "Klumpke's paralysis" should be discarded.

The violence causing the interference with function may be directly applied to the shoulder itself, or indirectly, or combined. The violence may be sufficiently great to cause a fracture in the neighborhood of the joint. In such cases the fracture—if a gross one—absorbs the surgeon's attention and accompanying conditions are subsidiary to it. Many cases, however, show no obvious fracture, and yet for months there may be pain on movement of the joint, and limitation in the range of movement. The cause of this pain and limitation is often obscure and not

infrequently the patient's curiosity is satisfied and the surgeon's omniscience safeguarded by the comforting phrases "sprain," or "rheumatism." A search for a focus of infection may be instituted, a carious tooth or a septic tonsil dealt with, and in course of time the condition improves, finally clearing up. So far all is satisfactory, unless the disability refuses to clear up.

The aim of the surgeon must always be to visualize the pathological anatomy of a lesion if his treatment is to be rational and his prognosis trustworthy, and one has the feeling that a good many chapters in the pathology of the shoulder-joint are still unwritten. Not at all uncommon is the condition of painful shoulder-joint following a fall on the outstretched hand, as described by Jones. (Injuries to Joints, 1915.) A Colles fracture may or may not be sustained. Some weeks later, pain and stiffness are felt in the corresponding shoulder-joint. The original violence has been transmitted directly to the humero-scapular articulation, bruising the cartilaginous surfaces. Cartilage being an avascular structure, time is required for the ingrowth of vessels to repair the damaged tissue, and after this has been done still further time is required for the obliteration of the reparative vessels, leaving the joint almost as good as before the accident, or else, which is much less likely, with impaired function due to intraarticular adhesions, according to the degree of violence and the damage sustained.

Violence which is frankly indirect may in a similar manner produce a traumatic bursitis affecting the subacromial bursa. Here we are dealing with tissue more readily vascularized; the onset is more rapid, and the reaction more acute than when the cartilaginous surfaces alone are involved. At other times the brunt of the fall is borne, not by the shoulder-joint itself, but by the clavicular flying buttress. The clavicle most frequently gives way. On the other hand, the medial extremity of the buttress may show the effect of the violence in an acute traumatic arthritis of the sterno-clavicular joint. The acromio-clavicular joint is not usually involved in lesions due to a fall on the outstretched hand, since the line of transmission of the strain is through the head of the humerus to the glenoid part of the scapula, and from there to the clavicle, *via* the conoid and trapezoid ligaments.

Most of our patients, however, who come with painful shoulders after injury describe the condition as resulting from "a fall on the shoulder," incurred in such activities as a railway accident, a fall from a horse, or tumbling down the basement steps in the dark. It is not always possible to get an exact description of the circumstances at the

moment of impact, but the broad fact emerges that it is a "head-first precipitation."

Sometimes there is actual evidence of violence applied to the skull. Frequently there is no abrasion.

Examination of the shoulder region immediately after the accident reveals considerable limitation of movement. Active movement is generally very limited indeed, while passive movement is apt to be painful. At this stage one must be guarded in regard to diagnosis. The general bruising usually clears up in two to three weeks and an estimate can then be formed of the full degree of damage done. It is at this stage that mistakes are likely to be made. The improvement has been fairly rapid in regard to relief of pain, and one is tempted to give a prognosis of continued amelioration. This is not always justified. Many of these shoulders will continue to be painful and disabled for many months, some of them permanently. Very careful investigation will frequently reveal marked tenderness about the supra-spinatus and infra-spinatus, the deltoid may be tender also, as well as the teres minor and teres major where they form the bulk of the posterior axillary fold. Careful comparison with the other side will generally display distinct atrophy of some of these muscles.

In examining a shoulder one's attention is too apt to be concentrated upon the deltoid to the exclusion of the other muscles, which must be acting well in order to give perfect function at the shoulder-joint.

Of these muscles, the supra-spinatus, and still more the infra-spinatus, are most liable to be injured. Next in frequency are the deltoid and teres minor, and after that the teres major and clavicular portion of the pectoralis major are apt to show atrophy. In some cases time will compass an almost complete restoration of function, but the condition where permanent weakness and atrophy of the infra-spinatus remains is an exceedingly common one. This is apparently the muscle most easily affected, and the absence of its action from the shoulder-joint muscle team constitutes a real disability. This is most pronounced when work has to be carried out with the arm raised above the shoulder level—*e.g.*, a carpenter working upon a roof—but the effect of its absence is usually made out fairly readily.

If the patient be asked to raise both hands straight in front of him to shoulder level, there is usually a difference in height, the affected side being slightly lower. Further, if the hand be stretched straight out from the shoulder in the coronal plane, the hand on the affected side is slightly lower and the affected shoulder is heaved up more

than the other. Another test that may be made demonstrating weakness of external rotation is to seat the patient squarely in front of a table, and ask him to sweep the hands outward while the elbows rest upon the table, the forearm forming the radius of a circle of which the elbow is the center. The lagging behind in the case of the affected side is usually well marked.

While the affected muscles are recovering they are usually distinctly tender to pressure, and this tenderness is likely to persist for many months.

What is the mechanism involved in these painful shoulders? Occasionally, perhaps, it is the partial rupture of fibers of a tendon which, while held taut, is suddenly subjected to an unusual strain. Such a case is the following:

F. A. C., aged 43, was struggling to wrest a knife from an intoxicated man. About half an hour later he began to have pain in the right shoulder region. When examined about three days later he showed no sign of bony deformity and no bruising, but slight fullness in the right infra-clavicular fossa, slight pain about the deltoid insertion, and marked tenderness over the lesser tuberosity of the right humerus. Active and passive movements at the right shoulder-joint were carried out fairly well except in the one direction of outward rotation, which was almost nil.

In this case there was, in all probability, some rupture of fibers of the subscapularis.

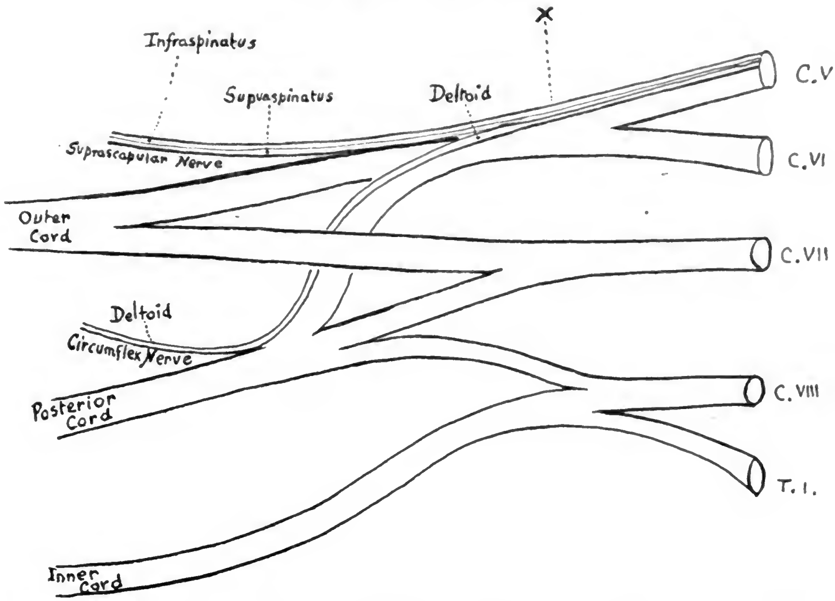
Most frequently, however, the widespread involvement of muscle, the long-continued tenderness, and the tardy recovery point to a different origin. When supra-spinatus and infra-spinatus alone are involved, one is tempted to attribute the condition to a lesion of the supra-scapular nerve alone. Where the nerve passes through the supra-scapular notch, the supra-scapular ligament is stretched tightly over it. The sudden stretching of the nerve might cause it to impinge on the ligament sharply, a movement equivalent to the nerve being struck smartly by the ligament, the sequel being a traumatic neuritis. In view, however, of the fact that the involvement is often more widespread, including deltoid and teres minor, one is tempted to seek a vulnerable point where fibers to these muscles are more closely associated. This one finds in the upper trunk of the brachial plexus. Forcible separation of the head from the shoulder places the upper trunk of the brachial plexus on the stretch, and this is apt to cause damage to any muscles supplied from the 5th and 6th cervical nerves. Now, of the muscles around the

shoulder the deltoid, supra-spinatus, infra-spinatus, teres minor, teres major and subscapularis, as well as clavicular fibers of the pectoralis major, are all supplied from the 5th and 6th cervical segments. Why the infra-spinatus should suffer most frequently and severely is doubtful, unless it be that the fibers going to this muscle are the uppermost fibers of the uppermost brachial trunk, which is extremely probable.

There is, therefore, in many shoulder injuries a minor degree of Erb's paralysis, exactly comparable to the birth palsies, due to exactly similar mechanism, and varying as widely in degree. The actual lesion, no doubt, varies from a hemorrhage into the sheath to actual rupture of nerve fibers. When the violence is severe there may be complete paralysis of the whole upper limb as in case M. S. All gradations from this are possible. The more gross lesions are not likely to be overlooked, but minor degrees of damage to the uppermost trunk are more frequently missed than observed. Patients are usually satisfied when the real state of affairs is explained to them, and a reasonable prognosis given. When surgeon and patient alike are waiting for something to turn up, neither is wholly satisfied with the other. Careful observation will frequently disclose a condition which affords a reasonable explanation of why the shoulder has not returned to normal, and if the slowness and uncertainty of recovery in nerve injuries be appreciated and explained, a more contented frame of mind is likely to prevail on both sides.

As regards treatment of these conditions, the general principles should be relative rest, active movement being permitted only to a degree which does not cause fatigue or pain. Passive movement is called for only in sufficient degree to prevent contracture. If the joint be moved once per day through its full range of movement this is sufficient. Massage and electricity may be useful adjuncts.

The illustrative cases are arranged to show: First, a brachial plexus lesion, involving the fibers of the 5th, 6th and 7th cervical. Next, a less severe lesion, involving only the 5th and 6th cervical. The third case is that of an old injury, where permanent damage has occurred to the fibres forming the supra-scapular nerve. The fourth case, seen shortly after the accident, has paralysis of the deltoid, the supra-spinatus, and infra-spinatus. Soon after he came under observation the deltoid recovered apparently completely, but the other two muscles were still out of action. The fifth case is one where the supra-spinatus and infra-spinatus fibers are still inactive, and this case shows a scar on the head which gives a key to the mode of occurrence of the lesion.



Brachial Plexus to show Path of Fibres to Infraspinatus, Supraspinatus, Deltoid.
X—Region where injury occurs in lesions described.

The sixth case, and seventh, are practically transient supra-scapular lesions.

ILLUSTRATIVE HISTORIES.

1. M. S., age 27. Laborer.

On the 18th of November, 1918, a wheelbarrow fell from a hoist, striking him on the left side of the head and the left shoulder. There was immediate complete loss of power of the left arm. When seen by me for the first time, on February 17, 1919, he showed much atrophy of the deltoid, spinati, posterior axillary fold; indeed, of all the muscles of the left upper limb, except the small muscles of the hand. Loss of sensation (pin prick) over radial border of forearm as low as the wrist. This was a severe lesion of the upper part of the brachial plexus, due to forcible separation of head and shoulder. Under treatment with massage, electricity, and the use of an abduction splint, the condition has very gradually improved, so that some power is present in nearly all the muscles. Most of the tenderness has disappeared, but over the infra-spinous fossa and posterior axillary fold this is still present.

2. C. L., 48 yrs. Millwright.

On October 11, 1919, patient was standing upon a plank, one end of which was supported by a beam and the other end upon a crane. The

crane was moved from under the plank, and he was thrown to the ground.

When examined on November 16, 1919, he had good power in the muscles of the forearm; at the elbow-joint only moderate power of flexion and good power of extension. Atrophy of the deltoid, supra-spinatus, and infra-spinatus was pronounced. These muscles responded to galvanism, but not to faradism. On December 11, 1919, increase of flexion at the elbow was noted, and by January 5, 1920, voluntary power was present in the deltoid. Improvement continued steadily. A note of June 10, 1920, states, "Marked tenderness on firm pressure over the infra-spinatus. Most of the flexion at the elbow is carried out by the brachio-radialis." Atrophy of the spinati even after fifteen months is still pronounced.

3. W. R. J., age 65. Market gardener.

Six years ago, while shingling a roof, fell about nine feet, striking his right shoulder. For about three months he could not lift the arm at all at the shoulder. Now he finds difficulty in working above the level of the shoulders.

Examination of right shoulder showed some limitation of movement in all directions for active, but none for passive movement. There was no atrophy of the deltoid, but complete atrophy of the infra-spinatus and partial atrophy of the supra-spinatus. One of the patient's chief troubles was that he had not quite the same old punch in boxing as before his accident. No treatment was advised in this case.

4. H. M., age 32.

On September 28, 1920, this man was in a railway accident. He does not know the details as to how he landed. He was in hospital for twelve days with fractured ribs.

When examined on October 23, 1920, the supra-spinatus, infra-spinatus, and deltoid, on the left side, were not acting. Marked tenderness was present over the infra-spinous fossa and the posterior axillary fold.

On November 23, 1920, practically a full measure of recovery had been obtained in the deltoid, but the atrophy of the other muscles mentioned was still quite marked.

5. P. P., age 50. Laborer.

On October 30, 1920, patient was standing in the back of a wagon when it suddenly started forwards, precipitating him to the ground. He injured the right parietal region of the skull and the right shoulder.

The head wound healed up rapidly, but, in spite of assiduous painting with iodine, the shoulder was still disabled.

When examined by me on January 3, 1921, a healed scar was observed over the right parietal bone. Swelling was present over the sternal end of the clavicle; atrophy was marked in the infra-spinous fossa. The deltoid was acting normally. Marked tenderness was present in the supra- and infra-spinous fossae. The supra-spinatus and infra-spinatus muscles reacted to galvanism, but not to faradism. In this case the record of how the lesion occurred is exceptionally plain.

6. Mrs. C. E. M., age 65.

On October 10, 1920, fell downstairs into the basement, injuring the left shoulder.

When examined on January 1, 1921, marked tenderness was present over deltoid, supra-spinatus, and infra-spinatus. The deltoid showed voluntary power. Limitation of movement made it impossible to test the spinati for voluntary power. Very slight atrophy was present in the infra-spinous fossa.

7. N. B. H., age 24. Farmer.

Was in same railway accident as Case No. 4, on September 28, 1920. Was in hospital with diagnosis of dislocation of left shoulder. When examined by me on October 11, 1920, there was some weakness of the deltoid and some tenderness over the infra-spinous fossa. No atrophy. By January 7, 1921, the deltoid had regained practically full power. Tenderness had disappeared from the infra-spinous fossa. An x-ray taken on October 11, 1920, shows a detached piece of bone, probably in connection with insertion of supra-spinatus.

It is important to recognize minor degrees of injury to the brachial plexus, not merely with a view to maintaining cordial relations between surgeon and patient, but still more on grounds of equity. Of the cases cited, two are cases where a claim for damages was made against a railway company. In three out of the seven the Workmen's Compensation Board required a report before instituting compensation. In only two out of the seven was there no medico-legal interest. These cases are comparatively common, and exact diagnosis is likely to be demanded much more frequently than before the Workmen's Compensation Act came into force. Recognition of the fact that the deltoid is not the only muscle acting upon the shoulder-joint, and that minor, even transient, injuries of the brachial plexus are frequent, will lead to fairer estimates of disability.

CONGENITAL ANKYLOSIS OF JOINTS OF HANDS AND FEET.

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CONGENITAL deformities of the hands and feet present a very interesting type of anomaly in that they illustrate how striking abnormalities in osseous structure may give rise to but little disturbance in function. Prior to the use of the x-ray there were few cases of ankylosis of the hands and feet reported, and the accounts were lacking in many details. It was not until 1902 that an exhaustive treatise on this subject appeared in the form of a monograph, by Hans Engel[1]. He divides these cases into four groups, differing from one another by the extent of the involvement of the osseous system and the hereditary factor.

GROUP I. ANKYLOSIS OF THE JOINTS OF THE HAND, WHICH, THOUGH PRESENT AT BIRTH, IS NOT HEREDITARY.

Such cases are found in the literature only in connection with pectoral muscle defects, and may be well illustrated by the following reports:

Benario[2], 1890. Defect of the right pectoralis major muscle and 4.5 cm. shortening of the right hand. The fingers have but two phalanges. Fusion of the soft tissues between the fingers. Marked hypertrophy of the nail of three fingers. Not hereditary.

Berger[3]. Boy with defect of the right pectoralis major. Fusion and shortening of the first three fingers. The little finger has only two phalanges, a long proximal and a short distal phalanx. Not hereditary.

Fürst[4]. Man with a defect of the right pectoralis major. Right hand poorly developed and fingers fused. The M. flexor digitorum sublimis inserts at the bases of the terminal phalanges proximal to that of the profundus on the second and third fingers. Thumb normal. The index finger has no middle phalanx. On the second finger the proximal part of the terminal phalanx is much shortened. On the ring and little fingers the middle phalanx is very short. The metacarpals are normal except for a shortening of Nos. 1 and 2. The usefulness of the hand is in no way altered.

Hoffman[5]. Man with a defect of the right pectoral muscles and a shortening of the arm. On the index and middle fingers a short middle phalanx is fused with the end phalanx. On the ring finger the joints are all present but motion is limited. On the little finger the middle phalanx is absent, and the proximal phalanx very long. There is marked webbing of the fingers. The man's occupation is limited to a coarse type of work.

Klaussner[6]. Man with a defect of the left great pectoral muscle and shortening of the hand. The fingers are webbed. All the phalanges are shorter than normal. The middle and terminal phalanges are fused on the index and little fingers. The usefulness of the hand is not impaired.

Poland[7]. Defect of the pectoral muscle, absence of all of the middle phalanges, and marked webbing of the fingers.

Skodowski[8]. Defect of right pectoral muscle. Defect of the middle phalanx of index and second fingers. On ring finger bony ankylosis between all three phalanges. Webbing present. Heredity not mentioned.

Stintzing[9]. Man with defect of right pectoral muscles. Poor development of entire right arm. Ankylosis of all distal interphalangeal joints. Heredity not mentioned.

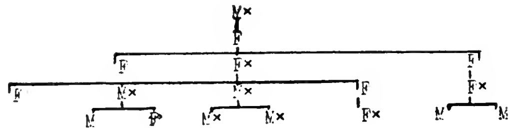
GROUP II. ANKYLOSIS OF CERTAIN FINGERS OF ONE HAND.

The corresponding fingers of the other hand are normal. The condition is hereditary.

Joachimsthal[10]. Father and daughter with abnormal shortening of the fingers and ankylosis of joints. On the first three fingers the very short midphalanx is united with the proximal phalanx. The site of the joint is marked by a thickening of the bone. On the little finger the middle and terminal phalanges are absent.

Pagenstecher[11]. Kyphotic girl with a small left hand. Heredity not known. The father is supposed to have a small hand. The metacarpals lack the normal tubercles, prominences, etc. The phalanges are small and short. On the middle finger the phalanges are fused into one bone. On the little finger the middle phalanx is absent.

Wolfe[12]. Ankylosis of the proximal and middle phalanges of one hand. The hereditary transmission of the defect may be understood from the following diagram:



GROUP III. HEREDITARY ANKYLOSIS OF THE FINGERS OF BOTH HANDS.

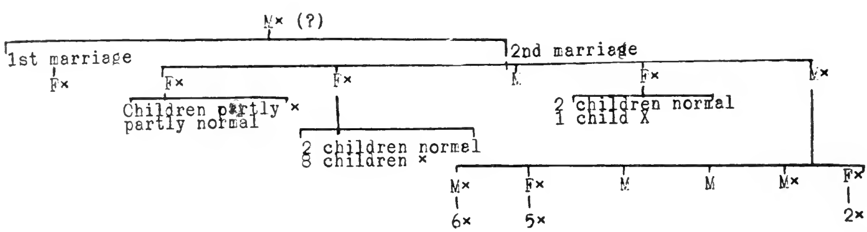
This group includes also the cases from the old literature in which only the defect in the middle phalanx is noted.

Colson[13]. A stunted development of the middle phalanges traced through three generations.

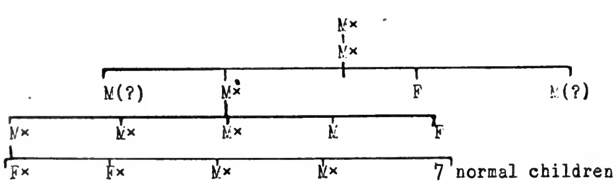
Joachimsthal[14]. Brother and sister with ankylosis of all of the interphalangeal joints. Defective nail formation and polydactylism.

Kellie[15]. A defective development of two phalanges of all fingers with exception of the thumb. The deformity had involved all the female members of the families through ten generations.

Kimmel[16]. Absence of the middle phalanx in many members of one family. Careful investigation of the family tree revealed the following deformities: Thumb — Broad, short, proximal and long distal phalanx. Index and middle fingers — Very long proximal and long end phalanx. Ring finger — Very short proximal, very long end phalanx. Little finger — Proximal and end phalanges same length. The usefulness of the hands is not appreciably diminished.



Walker[17]. Hereditary ankylosis of finger-joints of both hands through several generations.



The deformities were as follows: Ankylosis of the proximal joint of all fingers; absence of middle phalanx of ring and little fingers, except on left hand. All phalanges are present but fused into a solid bone. The sites of ankylosed joints are marked by a thickening of the bone. In all cases investigated the normal skin folds were absent over the ankylosed joints. The usefulness of the hands was not materially affected.

GROUP IV. HEREDITARY ANKYLOSIS OF THE HANDS AND FEET, INCLUDING THE BONES OF THE ANKLE AND WRIST.

This group may be illustrated by the following reported cases:

Kirmisson[18]. In one family the father and two out of six children affected by ankylosis of the hands and feet as follows:

Father: Congenital pes varus. Fusion of tarsal bones. In the hands, ankylosis of the proximal interphalangeal joints. Function of the hands very little disturbed.

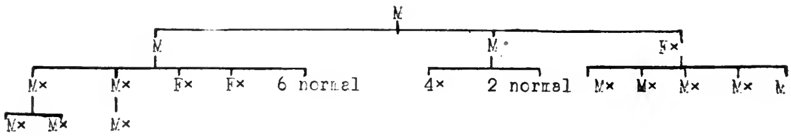
First Child: Boy with defects as the father, except that on the little finger the last two phalanges are fused.

Third Child: Girl with pes varus, ankylosis in tarso-metatarsal and interphalangeal joints, the tarsal region being one solid mass of bone. X-rays of hands and feet show the following defects: Hand—Fusion between proximal and middle phalanges of index and middle fingers on both hands; also on ring finger of right hand; also between middle and end phalanx of both little fingers. In the wrist the multangulum majus seems fused with the first metacarpal, the multangulum minus is separated from the capitalum and second metacarpal by a very indistinct boundary line. The triquetrum is either absent or fused with the hamatum. The pisiform is not recognized. The navicular lunatum and hamatum are clearly recognized. Foot—All middle phalanges absent. The two phalanges are fused on No. II and III toes. The first metatarsal is fused with the cuneiform. The second and fifth metatarsals show no proximal boundary line. The tarsal region is a solid mass of bone. The third metatarsal is poorly developed; the fourth very broad; fifth pushed laterally.

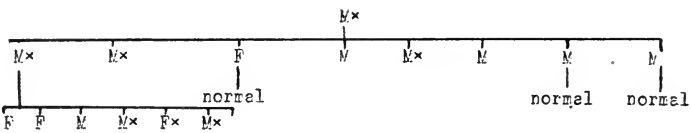
M'Kinder[19]. Defect of the middle and last phalanges of both hands and feet in many members of a family extending through six generations.

Ogle[20]. On the index and middle fingers are only two phalanges, on ring and little fingers only one. The affected fingers are without nails.

The same defects are present on the feet. The hereditary transmission is as follows:



Engel, H.[21]. Case A: Servant, male, 20 years. Left upper arm 1 cm. shorter than the right; left thigh 2 cm. shorter. All fingers and toes have only two phalanges, a long proximal and a shorter distal one. These defects do not hinder the usefulness of the hands or feet. The hereditary factor is as follows:



Hands:—In all joints of the hands motion is restricted. The normal skin folds are absent over the proximal interphalangeal joints where there is no motion. There is a thickening of the bone at the site of the ankylosis. Left index finger 8 mm. longer than the right.

X-ray:—Fusion of proximal and middle phalanges of first three fingers and of middle and end phalanges of the little fingers, the proximal phalanx being absent. Of the metacarpals the first seems widest. The other four have a thickening of the distal ends which is most pronounced on the index and diminishes toward the little finger. The first metacarpal is unusually broad, a condition which may be explained on the basis of it being a true phalanx and not a metacarpal. In the wrist one recognizes a naviculare, then a bony mass made up of lunatum and triquetrum; the pisiform is wider than normal. In the distal row is a multangulum minus and capitalum; finally a hamatum.

Feet:—Both feet are unusually broad and short. Motion in all joints restricted. Both great toes normal. Marked webbing of the other toes. Second toe has only two phalanges. The third toe of left foot is deformed and seems to be made up of only one bone; on the right foot it is unusually small, has a well-developed nail, and has two phalanges. On both feet the fourth toe is much shortened, has no nail, and is made up of only one bone. The little toes have but two phalanges.

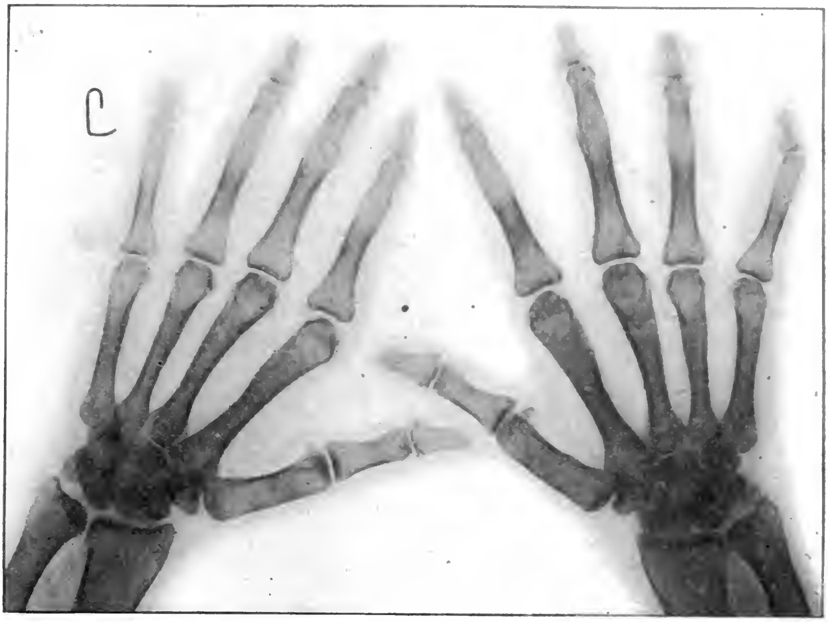


FIG. 1.—The proximal and middle phalanges of all of the fingers, and the middle and terminal phalanges of the left little finger are fused together by a bony ankylosis, the joint sites being marked by a thickening of the bone. The scaphoid is normal. The semilunar is fused with the unciform and cuneiform. The pisiform is normal. The trapezium is normal. The trapezoid and os magnum are fused together.

X-ray:—Middle phalanx absent from all toes. On left third, as well as both fourth toes, the end phalanx is also absent. Both sesamoids absent on the right great toe; on the left tibial, one only is present. The fifth metatarsal is displaced laterally and out of the line of the foot. In the ankle the cuneiforms I, II, and III are fused with the corresponding metatarsals, and on the right foot cuneiform III fused with the cuboid. The calcaneus, cuboid, and fourth metatarsal form one bony mass, which apparently is used chiefly in walking. The naviculare seems to be joined to the talus.

Engel, H. Case B: 18-year-old boy. Brother of Case A. Shortening of the left upper and lower extremities. Movement of joints of hands and feet limited.

Hands:—All fingers have no proximal joint, but a thickening can be felt. On ring and little fingers of right hand, the terminal joint also is lacking.

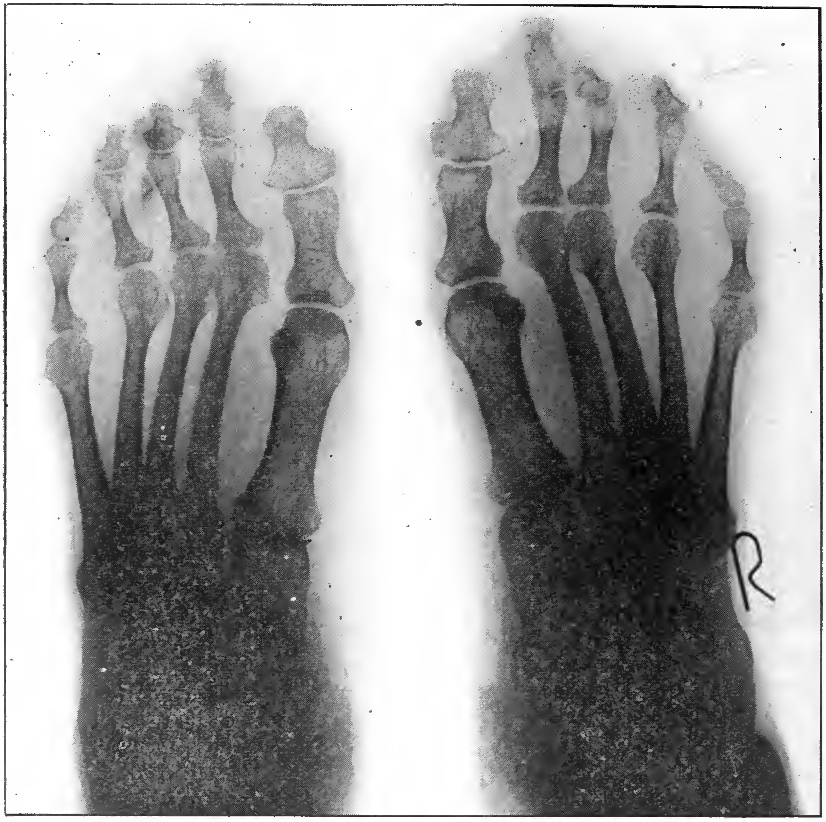


FIG. 2.—The proximal and middle phalanges of all toes except the great toes are fused together and form a wide proximal half of the distal phalanx. The metatarsals are normal.

X-ray:—On fourth finger of right hand, end and middle phalanges fused. At the site of fusion is a line which may represent the remains of an epiphyseal line or a joint space. At the site of fusion between proximal and middle phalanges of all of the fingers there is a thickening of the spongy marrow space. Epiphyseal lines of the proximal phalanges all show clearly. On the metacarpals all epiphyseal lines are present except No. I. One sesamoid bone is absent on the left hand.

Feet:—Both flat, unusually short and broad. On second toe midphalanx absent, the three last toes are very short and are apparently without joints; nail absent on third and fourth toes. Last four toes webbed.

X-ray:—Both sesamoids of great toes absent; second toes lack middle phalanx; other toes possess neither end nor middle phalanges;

FIG. 3.—In the tarsal region there are three bones instead of seven. Cuneiform I is normal. Cuneiform II and III are fused together. Cuboid, naviculare, astragalus and calcaneus are fused into a solid bony mass.

proximal phalanx very rudimentary. First metatarsal fused with cuneiform I; fourth fused with cuboid. Cuneiform II very small; cuneiform III fused with cuboid.

The case presented by the author is that of an Italian woman, aged 40 years, with congenital ankylosis of joints of both hands and feet, thus falling in Group IV, as classified by Engel. As far as she knows, none of her relatives have been similarly affected, and both of her children are normal.

Examination:—A well-developed, middle-aged woman, about 5 feet 4 inches tall, weighing 150 pounds. She walks with a noticeable shuffling gait. At first glance, the hands appear to be normal except for

an angulation at the distal joint of the right little finger, but upon closer inspection the skin folds over the dorsum of the fingers are not present and there is an ankylosis of the proximal joint of all of the fingers. Movement in all other joints is normal except for ankylosis of the distal joint of the left little finger. Motion at the wrist is free. The arms are equal in length and there is no defect in the muscular development about the chest or shoulders. The feet are extremely flat. All of the toes except the great toes have but one joint, the proximal one being ankylosed. The feet otherwise present no abnormalities aside from a reduced mobility of the ankles.

The x-ray reveals the following condition:

Hands (Fig. 1):—The fingers are of normal length and shape except for a lateral angulation of the distal joint of the right little finger. The proximal and middle phalanges of all the fingers, and the middle and terminal phalanges of the left little finger are fused together by a bony ankylosis, the joint sites being indicated only by a thickening of the bone over an area approximately 1.5 cm. long. This thickened area is made up largely of cancellous bone and the cortical bone is thinned out to a fine line.

In the carpal region five bones are present instead of eight. The scaphoid is normal. The semilunar is fused with unciform and cuneiform. The pisiform is normal. The trapezium is normal. The trapezoid and os magnum are fused.

Feet (Fig. 2 and Fig. 3):—The proximal and middle phalanges of all toes except the great toes are fused together and form a wide proximal half of the distal phalanx. The metatarsals are normal. In the tarsal region there are three bones instead of seven. Cuneiform I is normal. Cuneiforms II and III are fused together. Cuboid, naviculare, astragalus and calcaneus are fused into one solid bony mass.

COMMENT.

From the foregoing we may conclude, as did Engel, that congenital ankylosis of the bones of the hands and feet is usually hereditary, and when not hereditary it is, as a rule, associated with a developmental defect of the corresponding pectoral or shoulder group of muscles. The case here presented is out of the ordinary in that, as far as we know, the condition is not hereditary, and it is not associated with defects elsewhere in the body. The etiology of this condition is not known. Men are more commonly affected than women, and the hands

are more commonly affected than the feet. As a rule, the interphalangeal joints only are involved in ankylosis, but, as in our case, the carpal and tarsal regions may be affected as well. The fact that the thumbs are normal might lend weight to the view that the proximal bone of the thumb is a true metacarpal instead of a phalanx, yet developmentally the position of the epiphyses would confirm the opposite view.

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A SIMPLIFIED METHOD OF MEASURING AMPLITUDE OF MOTION IN JOINTS.

BY NEIL G. ROSÉN, M.D., NEW YORK.

THE great importance of accurate measurement of amplitude and strength of movements in disablement of the limbs is now well recognized and need hardly be emphasized by me. It is of vital importance in *treatment*. Here it gives the physician a record of the functional improvement taking place and of the effectiveness of the respective therapeutic measures instituted in each case. I know of many cases from my own experience in which there appeared to be no progress, but after accurate measurements had been recorded, it was found that a steady, albeit slow, increase in amplitude and strength of motion was taking place. The psychological effect of this on the patient is, of course, clear; it gives him a concrete evidence of the regeneration going on, which upholds his morale and greatly stimulates recovery.

Exact knowledge of the extent of disability present is also of paramount value in *medical reports*. Laws providing compensation for injuries sustained in industry are now becoming well-nigh universal, and the physician is often the sole arbiter as to the amount of disablement present. The justice of the awards depends on the accuracy of his records. Everyone who has had experience with the disablements resulting from the war, or with cases coming up for adjustment in the State Industrial Commissions, must admit the great difficulty that exists about indefinite reports. The following medical report was submitted in an accident case which came up for adjustment in one of the State Commissions, and I think it is illuminating. "There has been a fracture of the shaft of the humerus with possibly some overlapping of the fragments and considerable formation of callus. Motion in shoulder-joint is somewhat restricted; extension in elbow is slightly restricted. There is considerable decrease of motion in wrist-joint and loss of use of hand. The general tone and power of the muscles of the arm is diminished." Puzzle: Find the disability present. There are many similar reports in existence.

Another matter which is badly in need of attention is the great con-

fusion of terms used in recording measurements. In one report, for instance, it is stated that there is 45 degrees of flexion possible in the wrist; in another, the flexion in the same wrist is called 135 degrees. In the former the angle subtended by the hand and the forearm, when they are in a straight line, is considered as zero; in the latter it is called 180 degrees. Some writers compute range of supination from full pronation, others from mid-pronation. Sometimes the right angle in the ankle-joint is made the basic angle from which the motion in that joint is measured; at other times the complete angle formed by the foot and the leg is considered. Some physicians name anterior motion of the arm in the shoulder-joint, extension; others, flexion; sometimes the thumb is labeled the first finger; at other times the index is honored in this manner, and so on. It is very desirable that a uniform system should be adopted. It would do away with all this obscurity, and greatly facilitate the interpretation of the medical reports.

Actuated by the necessity arising through the war, when so many disabilities of the extremities had to be treated and recorded, a great number of instruments were devised to register the amplitude of movement at the various joints. Among these are "goniometers" for the knee-joint; specific instruments for measuring supination and pronation, and fleximeters for elbow, ankle, wrist and finger-joints. The "arthrodynamanometer" of Amar records the range of movement of the several joints, and also the power of the flexor and extensor muscles. The "dynamoergograph" of Camus records graphically the force, rapidity and amplitude of movement, and the fatigability of the injured limb. Amar's "Dynamographic Pear" registers the power of the partly paralyzed hand.[1] For description of these instruments I refer the reader to the literature on the subject. They are all more or less complicated, and while of great value in exact scientific work, the great majority of these apparatus are too elaborate for routine work. The larger joints may be measured comparatively easily with a simple fleximeter, but the difficulty has been to find a practical way of measuring and recording disability of the finger-joints. Dr. J. Appleton Nutter of Montreal, Canada, to whom I am indebted for many valuable suggestions which have been made use of in this paper, published an article in the *Journal of the American Medical Association* in 1919[2], in which he pointed out that, on account of the great number of joints involved, the tabulation of deformity and motion of the fingers in degrees has been found a most tedious undertaking. Such records, how-

ever accurate, are also very unintelligible. He described a very ingenious method of graphically recording the deformity of the finger-joints by means of diagrammatic drawings representing the hand and fingers. These drawings were made free hand, and in them a single line or succession of lines represented forearm, wrist, and each of the three phalanges. Free-hand drawings, useful though they are as a guide in treatment, bring in the personal factor, and will vary as the skill of the individual differs in estimating the several angles involved. They can hardly be accepted as scientific or legal records.

In the following, I have endeavored to present a simple system of measuring and recording range of motion in the extremities, which I believe is not readily open to misinterpretation, and is sufficiently exact for use in industrial accident work, and for the general practitioner.

Mensuration of Amplitude of Motion in Finger-Joints by the Aid of the Author's Phalango-fleximeter:

By aid of the phalango-fleximeter which is described below, the deformity and range of movements in the fingers is registered, and recorded graphically with exactness and rapidity, and the result can be read at a glance.

The apparatus (See Fig. 1 (a) and Fig. 1 (b)) consists of two main parts, a metal plate ab, and an irregularly shaped disc, D; the latter being joined with the former through aperture in elevated part of ab, by means of screw S, in such a manner that when the screw is loosened, D revolves through S. The plane of ab is at right angle to D. About one inch posterior to S is a notch K. D is made of thin celluloid, with a glazed surface for marking with a pencil, such marking being erasable. The plate ab is placed securely on the dorsum of the metacarpal bone, corresponding to the finger which is to be measured, so that K comes exactly opposite the metacarpo-phalangeal joint (the knuckle), and D is suspended between the finger to be measured and the adjoining finger; the center points of the dorsal surfaces of the proximal and distal interphalangeal joints, as well as the tip of the finger, are then marked off on the disc. In order to get a graphic record, a transparent sheet of paper is now placed on top of D, so that one border of the paper is parallel with ab and touches K. Point K, as well as the three points marked off on the disc, are copied on the paper and connected by straight lines (See Fig. 2). It can readily be seen that this gives an exact record of the deformity present in the finger; by making one record of flexion and another of extension, and placing one over the

other, you may read the range of motion at a glance. By loosening the screw S, D can be adjusted so as to fit hands of different size, and also to the thumb, which requires more space on account of its thenar eminence. The disc D, as well as the plate ab, are identically the same on both sides, so that one side can be used for the two medial and the other for the two lateral fingers on the hand.

Mensuration of Amplitude of Motion in the Large Joints:

Motion in the large joints, excepting the shoulder- and hip-joints, and the rotary movements, may be registered with fair accuracy, as has already been stated, by means of a simple fleximeter; a practical type is shown in Figure 3. The fleximeter is placed alongside the joint so that the pivot of the instrument comes right opposite the pivotal point of the joint, and the two arms of the fleximeter are parallel, respectively, with the upper and lower bones forming the articulation. The range of motion is then read off in degrees on the circular scale attached to the instrument; the scale should be marked to 360 degrees. The shoulder and hip-joints may conveniently be measured by means of a chart, such as is reproduced in Figure 4. This chart is placed on the wall and can be raised and lowered by means of a string and pulley, so as to bring the centrum of the chart opposite the shoulder- or hip-joint, respectively. When flexion and extension is registered, the subject is placed sideways, and when measuring abduction and adduction, with the back to the chart.

The principal rotatory movements which need registration in routine work are: inward and outward rotation in shoulder, supination and pronation of forearm, inward and outward rotation in hip, and inversion and eversion of foot. The amplitude of these movements cannot be measured by any simple instrument. By carrying out the following procedure, however, they may be computed with approximate accuracy.

Inward and Outward Rotation in Shoulder-joint:

Place upper arm parallel with body, with right angle in elbow-joint, and forearm in antero-posterior plane. Forearm can then be moved outward slightly more than 45 degrees, normally, and inward until restricted by body; by noting the excursion of the forearm, the amount of rotation present in the shoulder can be easily computed.

Supination and Pronation of Forearm:

Place arm in the same position as stated above, hand vertical with

thumb up; in this position forearm can normally be pronated 90 degrees and supinated 90 degrees; by using the thumb and hand as an indicator, any deviation from the normal can be estimated.[3]

Inward and Outward Rotation in Hip:

If subject is able to stand: place feet parallel in antero-posterior plane (one foot apart for inward rotation), and mark rotation on the floor; if bed-ridden, place patient on level couch and measure angle formed by foot and couch. Measure both sides for control.

Inversion and Eversion of Foot:

This motion cannot be measured with any accuracy in degrees. It is best expressed in percentage of normal, counting the normal as 100 per cent.

Tabulation of Measurements:

The following system has been adopted at the Clinic for Functional Reëducation in New York after a lengthy trial, and has been found accurate and easy to interpret. I wish to express my thanks to Dr. William V. Healey, who was mainly responsible for its introduction in the above institution, and whose method has been followed in this account.

In this system the angle formed, when extreme extension is present in a joint, is never made the basic angle for mensuration, nor are the various "neutral" positions considered. The angles presented in these positions are not constant. They vary in different individuals, and sometimes also in the corresponding joints of the same individual, due to structural dissimilarities, which may be either physiological or pathological. The only thing that concerns us is the size of the angles subtended at the two extremes of the excursion in the joint; the difference between these two gives us the range of motion which, when compared with the normal, expresses the disability that is present. For instance, on measuring the amplitude of movement in the wrist-joint shown diagrammatically in Figure 5, the active flexion is registered first; it is 135 degrees. The limit of active extension is then registered from *the same side;* it amounts to 225 degrees in this case. On subtracting the former from this figure you get the range of motion, which here is 90 degrees. When passive motion is to be registered, the procedure is the same, excepting, of course, that the mensurator has to perform the movement. A report for voluntary motion may be made out as follows:

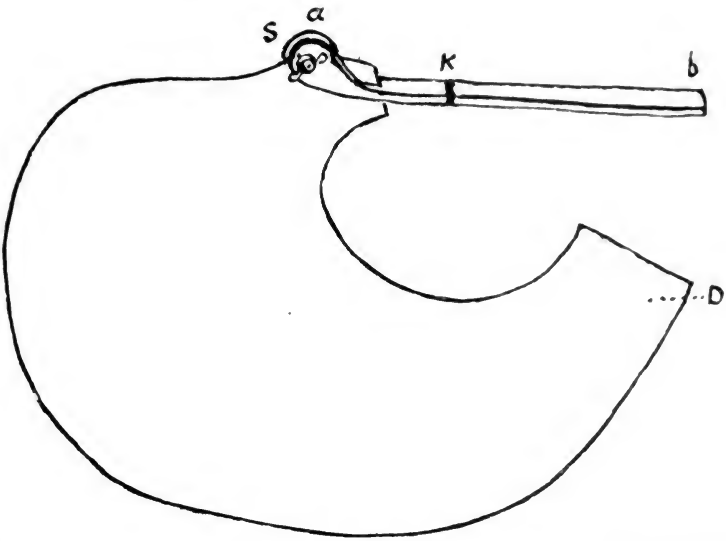

FIG. 1 (a).—Phalango-fleximeter (Rosén).

FIG. 1 (b).

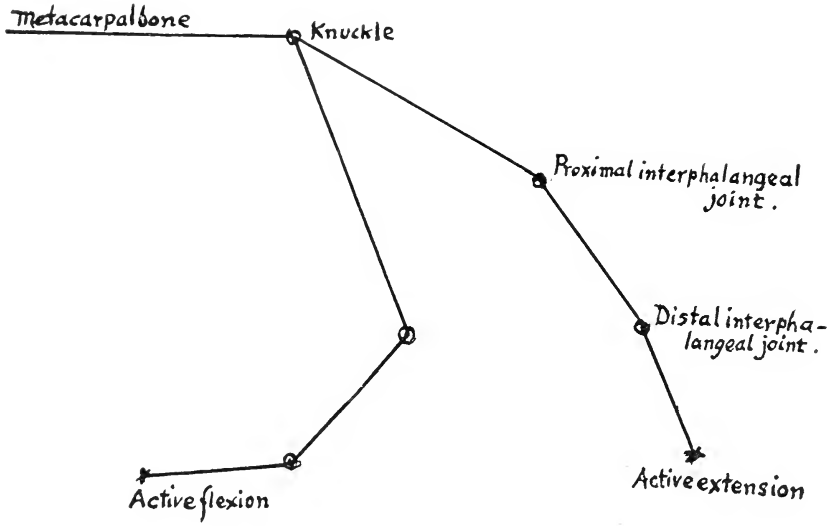

FIG. 2.—Graphic record completed.

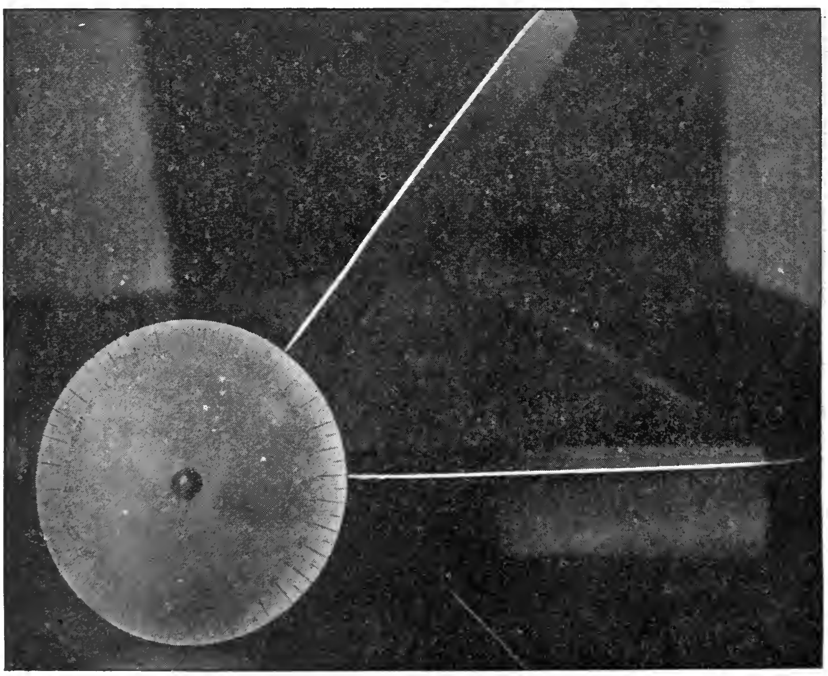

FIG. 3.

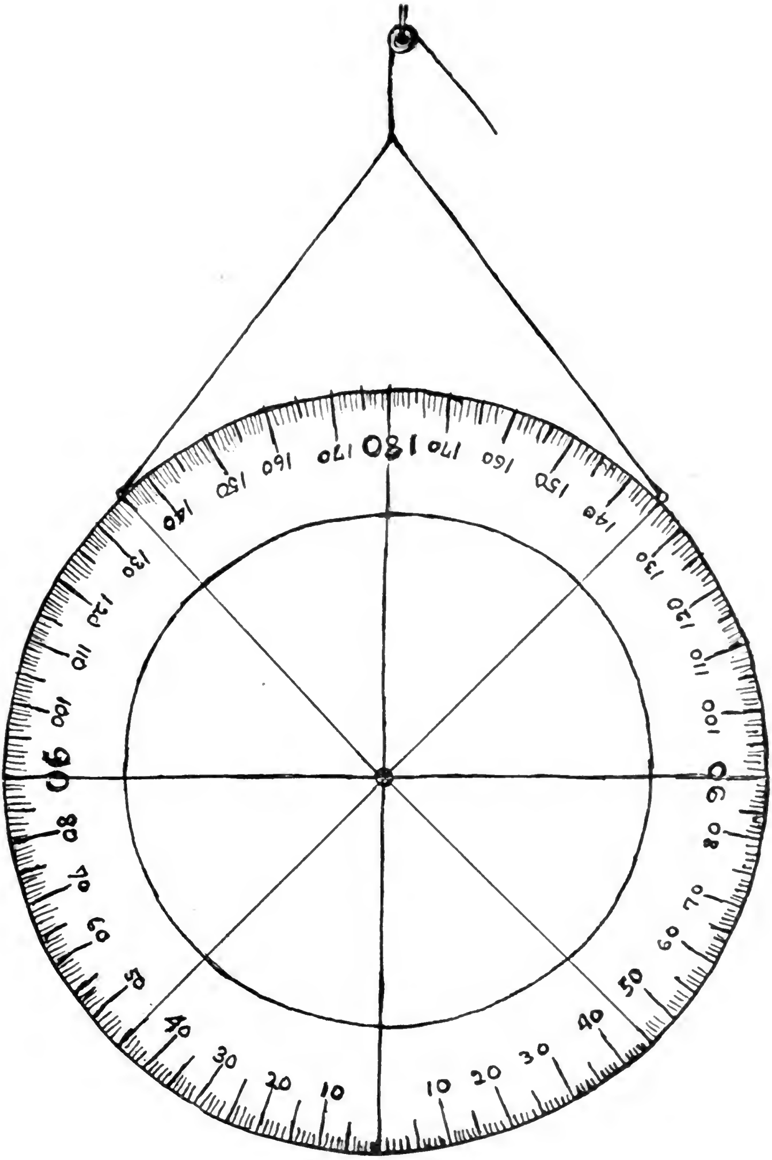

FIG. 4.—Chart for measuring motion in shoulder and hip.

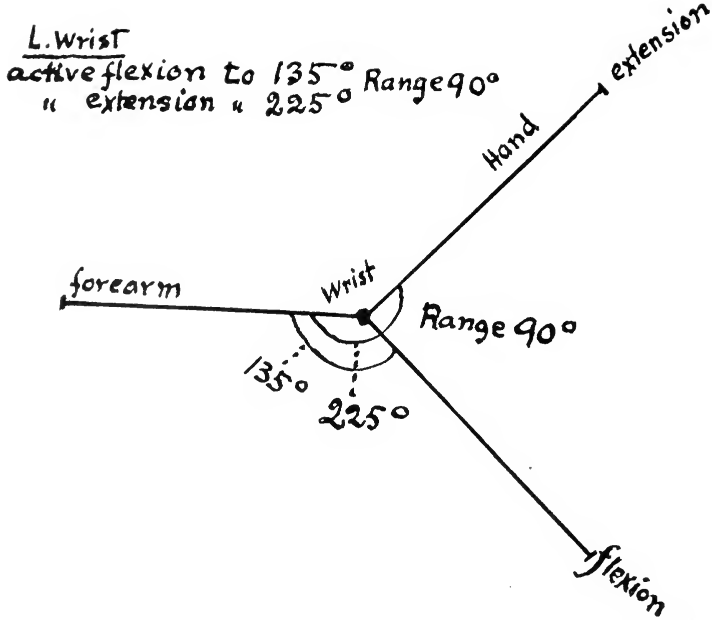

Fig. 5.—Diagram showing method of recording range of motion of wrist.

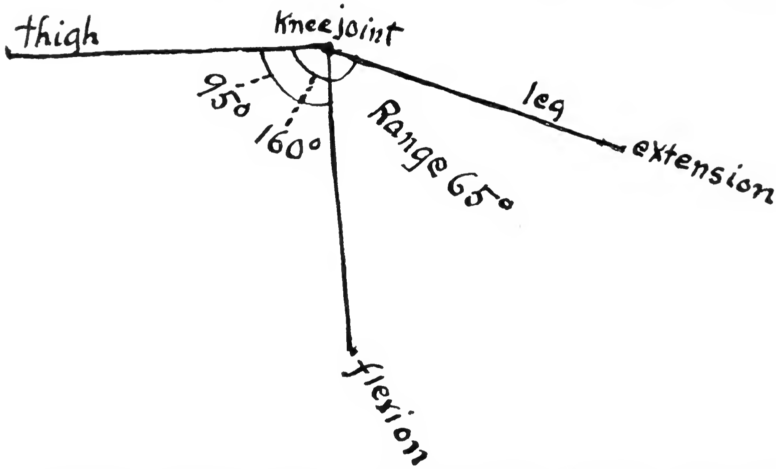

Fig. 6.—Diagram showing method of recording range of motion in knee joint. Right knee—Active flexion to 95°; active extension to 160°. Range 65°.

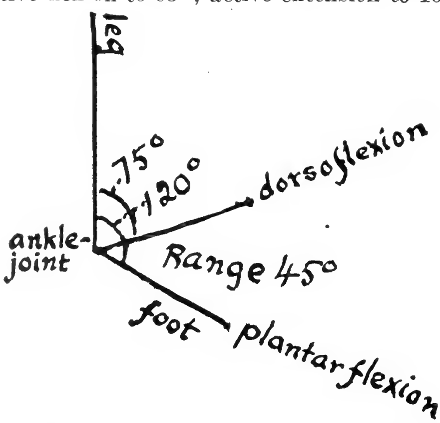

Fig. 7.—Diagram showing method of recording range of motion in foot. Right foot—Active dorsiflexion to 75°; plantar flexion to 120°. Range 45°.

Left Wrist:

Active flexion to 135 degrees	Range 90 degrees.
Active extension to 225 degrees	

If the hand can be moved passively 10 degrees further in each direction, you tabulate the involuntary motion in the same manner:

Passive flexion to 125 degrees	Range 110 degrees.
Passive extension to 235 degrees	

Figures 6 and 7 show the procedure in measuring the knee- and ankle-joint, respectively. If desired, diagrammatic drawings, such as here represented, may also be made, in order to facilitate the interpretation of the reports.*

Recording the Strength of Motion:

At the Clinic for Functional Re-Education in New York, where we have had considerable experience in making case records of joint deformities caused by gunshot wounds and industrial accidents, dynamometers are not used in routine mensuration of strength of motion at the various joints, excepting for the grip. This is registered by means of a simple contrivance having a compressible spring and a scale registering in pounds. In the other joints the strength of motion is compared with that of the corresponding joint of the sound side wherever possible, and expressed in percentages, counting the normal as 100 per cent. strong. This method has been found very satisfactory.

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*Printed charts, showing the extremities with range of movements marked in degrees, were issued by the Centre for Physical Treatment, Versailles, France, and also by the Canadian Government during the war. They proved a great help in elucidating the case-reports of disabilities.

SPINAL PATHOLOGY IN RELATION TO OCULAR MANIFESTATIONS, WITH REPORT OF CASES.

BY C. L. LOWMAN, M.D., LOS ANGELES, CALIF.

As the outcome of the work done by Dr. Lloyd Mills and myself during the last five years has so satisfactorily proven the correctness of our original premises, and as we have established with comparative definiteness the relations between irritative lesions of the spine and eyes, it is desirable to consider the present status of this work and further conclusions to be drawn from it.

Both eyes and ears, as the chief channels of afferent sensation, play a very decided and important part, probably the most important part, in relating us to our environment, and also as a part of the position sensing mechanism. The tactile sensory machine with its end organs in muscles, joints, and skin, is almost equally important. It works in such close harmony with eye and ear that in certain phases of physical activity it is difficult to tell which is most important.

Probably there is no other example of this interaction so marked as that seen in "attending" to a given activity. Anything that obtains the attention of the mind does so by using one or more of the sensory paths to convey the continued stream of afferent stimuli to the brain. This in itself necessitates continued motor activity in physically controlling the pathways needed for the conveyance of such impulses.

For instance, suppose as the result of a mental stimulus you take up a book to read. In order to properly fulfill the motor expressions necessary to such reading a continuous stream of efferent impulses must flow to the muscle group involved in making reading possible. The hands and arms must hold the book at a given distance and angle, thereby calling into play the tactile end organs in the skin, muscles, and joints for information as to the position of the book in relation to the body; all the muscles of the body must maintain a fixed position in relation to the chair; the head must be stabilized in the proper position for the best use of the eyes—a position which would vary in accordance with the visual needs due to the physical condition of the eyes. This posture must be maintained constantly fixed so that no part will move or wobble and interrupt the stream of visual sensations

passing the sensorium. If a person were sitting listening to a speaker, there would be the same sort of adjustment necessary, except that the auditory pathway would be first in importance and the visual would come next.

In an activity involving coördinated movements, as in some occupations or games of skill, other pathways also would have to be maintained for the recognitions of sensations necessary to proper control. Fine balance control of the whole body, or any part of it, may be required also as a part of both the sensory and motor phases of any activity in which the mental attention must be carefully directed.

In orthopædic surgery we are rather apt to think only of the grosser aspects of muscle activity, such as the control of bony levers or the production or control of gross deformities. We thus overlook some of the finer phases of muscle physiology that involve the more delicate and intricate activities associated with varying brain states and necessary for the proper functioning of the finer parts of the body, as, for instance, the eye, ear, and speech mechanism. As has been previously pointed out by the author in an article,—"The Effect of Faulty Skeletal Alignment upon the Eye,"—which appeared in *The American Journal of Orthopædic Surgery* for December, 1918, and by Dr. Lloyd Mills in "The Effects of Faulty Cranio-spinal Form and Alignment upon the Eyes," which appeared in the *American Journal of Ophthalmology* for July, 1919, there is a very extensive and highly coördinated activity involving the whole position-sensing mechanism which includes the labyrinthine apparatus, the muscle groups, especially of the head, shoulder girdle, upper back and arms, and most of the rest of the body, as well as the organs of special sense, chiefly the eye and ear. When we realize that, aside from the usual duties of this complex position-sensing, balance-controlling, attention-fixing mechanism, our actual thought forces are constantly evidenced throughout our muscular system by the most delicate changes of muscle tension, we can see how in certain individuals it is easy to have produced those conditions of muscle and nerve strain which group under the symptom complex known as "postural strain."

Our muscles are actually "organs of will" and our thoughts and emotions are made known to the outside world only by the motor response to the stimuli from the will. Even the subconscious neural control of most of the automatic reflex acts has at one time been developed under conscious control, and by repetition certain habitual and automatic reactions have become established.

Static strain begins primarily as malfunction, but due to the continuance of such faulty function and to the production of the well-known vicious circle, actual changes in the tissues are gradually produced. These changes begin with ligamentous and muscle tension and are followed by cramp in the muscles (often a mild myalgia), effusion around the points of insertion of ligaments and tendons, fibrositis, periostitis, periarthritis, and arthritis.

"Neuritis," so called, is a usual accompaniment or result, and disturbances due to the involvement of the nerves in that locality frequently are so marked as to obscure the underlying condition, and often result in the treatment of the symptom and not the real condition. This fact has been especially noticeable in the group of cases under consideration. We frequently found that such symptoms as pain down the arm, "tingling," "numbness," "prickling" in hands, arms, and shoulder, had been treated for "neuritis" without further investigation of spinal or shoulder girdle form or alignment. The collaboration with an oculist, skilled in the methods of measuring ocular muscle imbalance, is essential in the treatment of these cases of cervical and cervico-dorsal lesions with irritative symptoms. It has been the means of bringing relief to a class of cases whose numbers are legion and with which every practitioner is more or less familiar.

When a patient comes in for sub-occipital aching or pain in neck and shoulders that is always made worse by any attempt at concentrated work, such as "sewing," "reading," "driving," or "bench work," it is useless to attempt to give relief by purely local means. Not only must the whole body posture be rectified, but an eye examination is always indicated. Before such a case can obtain permanent relief and benefit it is necessary to ascertain whether there are elements of the eye muscle imbalance and ocular strain increasing and causing the condition, or whether the relation of cause and effect is the other way round.

A reference to certain eye positions in torticollis was brought out many years ago by Gould, but as we have shown in previous papers, the question of the production of eye muscle imbalance, faulty eye function, chronic inflammatory conjunctivitis, glaucoma, etc., by irritative spinal lesions and postural faults, we feel has never been established previous to our findings in 1915.

The principal local lesions which we have found to be associated with this eye and balance complex are: cervical rib, typical and atypical; osteoarthritis in the cervical and cervico-dorsal region; fibrositic

deposits; scoliotic twists and curves; impingements of lateral processes, especially abnormally large or long seventh cervical ones; impingements of the posterior processes in cervical lordosis compensatory to antero-posterior spinal mal-alignment; and minor luxations or subluxations of one or more vertebrae with restrictions of normal movements of the parts involved.

The effect of these lesions on the eyes is unquestionably produced through the irritation of the cervical sympathetics. This is ably shown by Dr. Lloyd Mills in a paper read before the Eye, Ear, Nose, and Throat Section of the California State Medical Convention, May 20, 1920, entitled "Significance of Spinal Defects and Pain Occurring in Relation to Ocular Diseases." The same effect may also be produced through nerve strain and irritation of the labyrinthine mechanism which is so intimately involved both in eye activity and in balancing function of the muscle groups used in fixing the shoulder girdle, neck, and head. It thus acts as part of the visual apparatus, as pointed out in a previous paper.

Aside from the effect on the eyes due to direct irritation, there are undoubtedly gross effects, produced by strain in this visual balancing function, due to gross faults of spinal alignment. Another more indirect effect is that due to the increased neural effort which mal-alignment and the lowered muscle tone makes it necessary to expend to accomplish a given act that normally could be done with much less effort.

We also feel sure, from certain facts brought out in the treatment of spastic paralysis cases with athetoid movements and in certain habit spasm cases, that not sufficient consideration has been given to muscle fatigue and the toxaemia incident to it. Muscle groups which are required constantly to maintain fixed postures will necessarily be unduly fatigued when they have to overcome skeletal faults and compensate for irritative lesions by having to guard sore and sensitive areas. Now, as the control of so many muscular reactions is entirely reflex and the neuro-motor mechanism involved must be delicately susceptible to all changes in nervous states, we feel that these fatigue toxins increase the excitability of the reflex arcs and tend to keep up vicious over activity of the corresponding muscle groups. When such muscle groups as are concerned with the delicate functions of vision, audition and the finer coördinated movements of hand and arm are involved, the resultant overwork adds to the burden which is ultimately evidenced as strain, pain, and dysfunction.

In considering these local cervico-dorsal lesions, I should like to call

attention to the close analogy in the defects themselves as well as the symptoms produced, to similar states existing at the lumbo-sacral area where faults of form and alignment are so common. I should like to say in this connection that I consider a large percentage of the so-called "sciatic neuritis" cases to be due to exactly similar factors as occur in the neuritic types of cases in the shoulder girdle area which are under discussion. The author, who has experienced a traumatic strain of the right sacroiliac, followed by chronic irritation and soreness in that area ever since, has recently found on analysis that a constant aching of the right side of the pelvis, back and hip, noticed so often while driving an auto, really resulted from using the foot throttle. You can readily see that to expect the larger muscle masses of the foot and leg to keep up so fine a balance extension and flexion of the foot, requires the fixing of the femoro-pelvic muscle groups which extend into the lower back. This is an *attention* strain exactly like what occurs in holding a book still enough for the use of the eyes.

We see a similar action of reflex sympathetic irritation through the sacrosciatic plexus, involving frequently the pelvic and abdominal organs. Often this is evidenced by the relief and by the improved function in pelvic viscera when the spinal alignment is improved and local strain eliminated. The reverse is also true, *i.e.,* backaches and low-back pains are relieved when pelvic irritations are removed. Frequently conditions involving one plexus may be frankly transferred to another. It is not unusual to have patients, who come for postural faults of the lower back, feet or legs, state after their correction, that they notice marked improvement of the eye condition. We commonly see, also, a decided improvement in the function of the abdominal viscera after a correction of the spinal alignment. Similarly through the sympathetic reflexes we also know that certain ocular conditions can produce nausea.

I will briefly mention a few cases in which the radiographs show spinal defects, in order to illustrate the types of conditions found in connection with eye findings and will cite a little more fully a representative case to show the resulting benefit to the eye condition from the correction of a lumbar scoliosis referred to me for sciatica by a specialist on tuberculosis.

CASE 1. Miss G., aged 35 years. Entered October 4, 1915. Diagnosis: Scoliosis, right dorsal, left lumbar, with pronation and depressed arches. Bronchitis for several years—incipient tuberculosis—had been

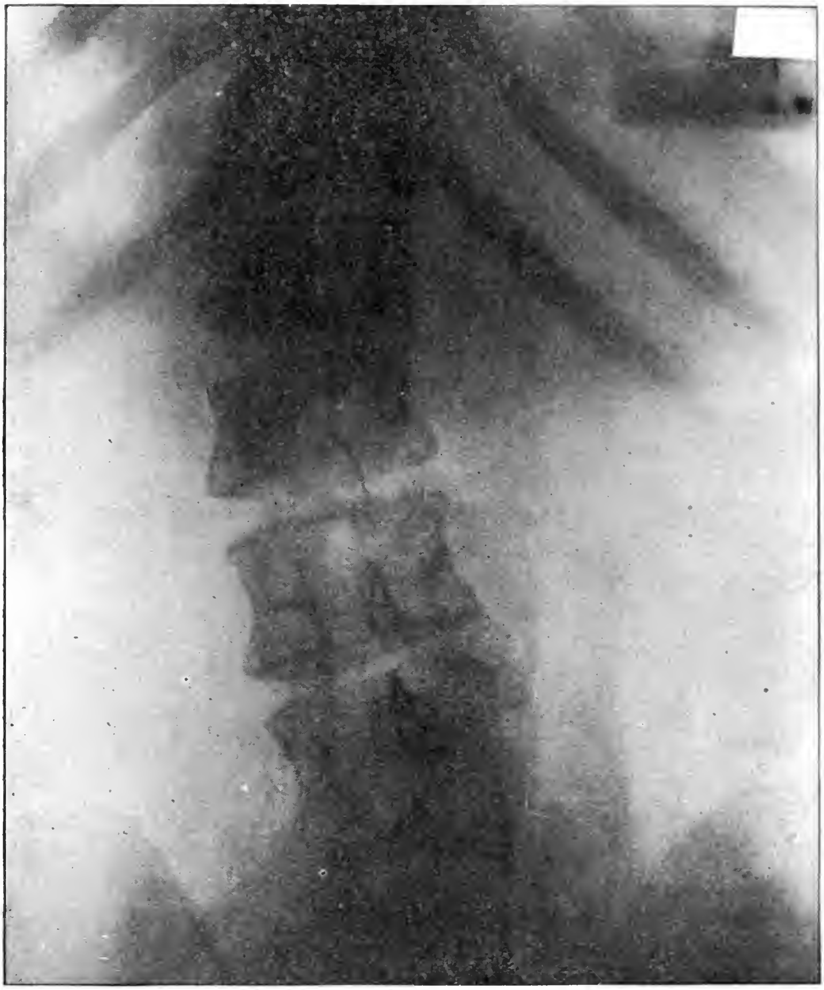

FIG. 1.—Miss G. Age 35. Diagnosis scoliosis—with secondary neuritis—sciatic and cervico-dorsal.

at sanitarium for five months—much improved chest condition. Pain in lower back, worse during menstruation—constant pain just below the waist. When she sits up quickly in bed after lying on back, has sharp pain and crepitation in the left sacro-lumbar region. After standing up, pain is radiated to the left as far as the crest, but not down the leg—neuritic symptoms over neck and shoulders—plumb line from mid-heel passes one inch to the left of the nates—left posterior superior spine one inch lower than the right—right dorsal left lumbar

curve—left leg about one-half inch shorter than the right. Scoliosis was very nearly corrected by five modified Abbott jackets followed by brace and exercises; back symptoms all relieved—condition very good at present—eye condition changed very markedly.

Examination of the eyes February 26th, 1916, showed following condition: Left hyperphoria, 1°; exophoria near ½°; esophoria 1¾°; abduction, 3°; adduction, 7°.

Report of April 20, 1920, as follows: "Miss G. has, at this date, a vertical and lateral orthophoria. Exophoria for near 4°; abduction, 4°; adduction 30°.

This constitutes a perfect balance. Her eyes have lost all appearance of strain and irritation." Report from Dr. Lloyd Mills.

Case 2. Elizabeth B., aged nine years. Entered March 4, 1919. Generally relaxed posture in a chunky girl, slightly overnourished—round shoulders—hollow back—very nervous, with muscular twitching and nervous stability poor—fatigues easily.

After six months of corrective work mother informed me she had gone to their optician who sent me word that she had reduced an exophoria from 20° to 7° by June, 1920, and was very markedly improved visually.

"Eye findings December 13, 1920, showed esophoria 3.00; left hyperphoria, 2.00. Prisms swung to 60°. O.D. base up and in, O.S. base down and in as a temporary expedient awaiting further tests to ascertain if improvement is permanent. The left hyperphoria reduced between October 8, 1920, to December 13, 1920, from 7° to 2°." This was a report from Dr. E. A. Hutchinson.

In January, 1921, she was allowed to discontinue active supervised work because of improvement to so satisfactory a condition.

Case 3. Mrs. H. Patient came in from Nevada in March, 1919, for treatment of anterior metatarsalgia and asked to be referred to an oculist because she was having trouble with her eyes. Her feet were padded and she returned in ten days, stating that she "wouldn't have to go to an oculist as her eyes were O.K. since pain in feet was relieved."

Reported January, 1921, that she had had no further neuritis or eye trouble.

Case 4. Mrs. D. C. Entered February, 1918. Diagnosis: Anterior

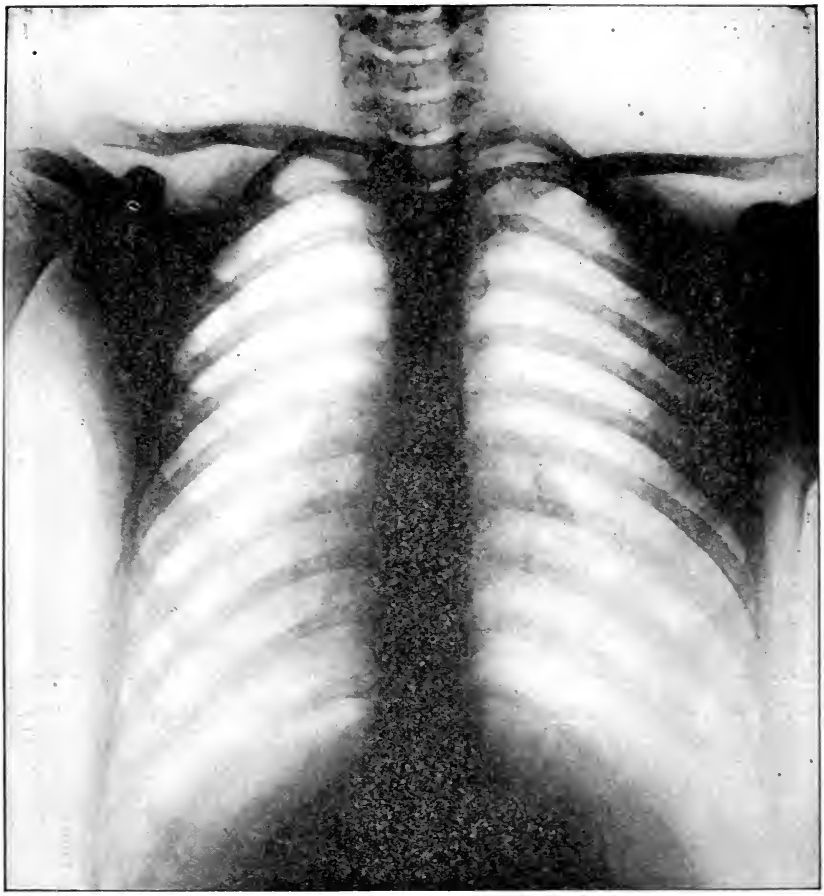

Fig. 2.—D. S. Age 8. Torticollis—with marked muscular eye imbalance. Note difference in height of clavicles.

metatarsalgia and postural back strain. History showed severe eye trouble for years. After static correction, she began to see well enough to sew again. Sprained ankle and went on crutches. Eyes immediately became worse, and improved when crutches were discontinued.

Dr. Forgét, her oculist, reported subsequently that eye condition was markedly improved, due to improvement of muscular imbalance. Patient died of "flu" in 1919.

Case 5. D. S., aged eight years. Diagnosis: Torticollis. Entered September, 1919. Eye findings showed characteristic muscle imbalance

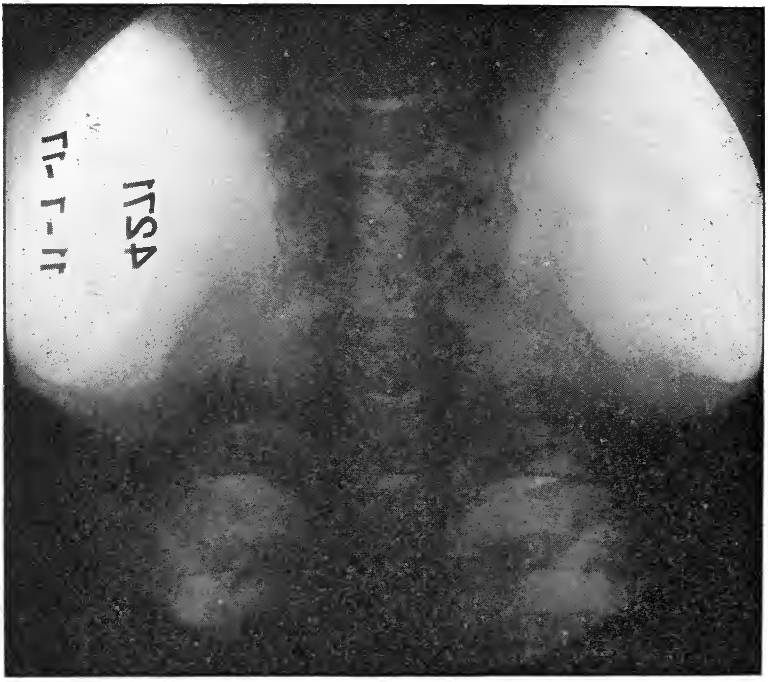

FIG. 3.—Mrs. L. Diagnosis—Cerv. neuritis and postural strain. Eye—Diag. sympathetic conjunctivitis.

as follows: Abduction, 6°; adduction, 1°; L. hyperphoria, 1½°; exophoria, 4½°; exophoria near 10-13; visual acuity, 6/6. Mother refused operative correction until after trying Christian Science.

CASE 6. Mrs. L., aged 40. Diagnosis: Cervical neuritis and postural strain. Referred by oculist for neck symptoms—old history of typhoid and questionable spinal trouble afterward—formerly diagnosed as neurasthenia—eye condition a chronic conjunctival congestion without secretion, which was entirely relieved in three months of corrective treatments, balancing by means of shoes and corrective corsets, local massage, hydrotherapy and manipulation — chiefly traction — followed by active-passive exercises. X-ray showed scoliosis and especially cervical lordosis.

CASE 7. Miss J. H., aged 28 years. Entered December 13, 1915. Complaint: Pain in back of neck. Her history shows that she was extremely sensitive to noises—very nervous—slept poorly—concentration

FIG. 3a.—Mrs. L. Lateral view. Marked cervical lordosis and slight hypertrophic changes.

caused increased pain in neck—the glasses which she had did not relieve the nerves. She went to an osteopath ten years before for pain in neck. He manipulated neck, causing it to snap—obtained some relief, and found she could "snap" it herself, which she kept on doing, with a development of marked fibrositis, for which she was sent to us. Treated by fixed immobilization, then Thomas collar, corrective corsets, massage, traction, hydrotherapy, corrective exercises. Her oculist in Riverside reports her "a changed individual, no longer neurasthenic, and eye condition almost entirely relieved."

CASE 8. Miss T. Referred by oculist December, 1919, because of sensitive spots in cervical and cervico-dorsal areas—spells of blindness and a sore place on the occiput. Patient had been tubercular for some time, and examination showed badly relaxed posture. X-ray of spine showed a decided cervico-dorsal scoliosis—neck shorter on the left—seventh cervical vertebra tilted sharply downward to the right.

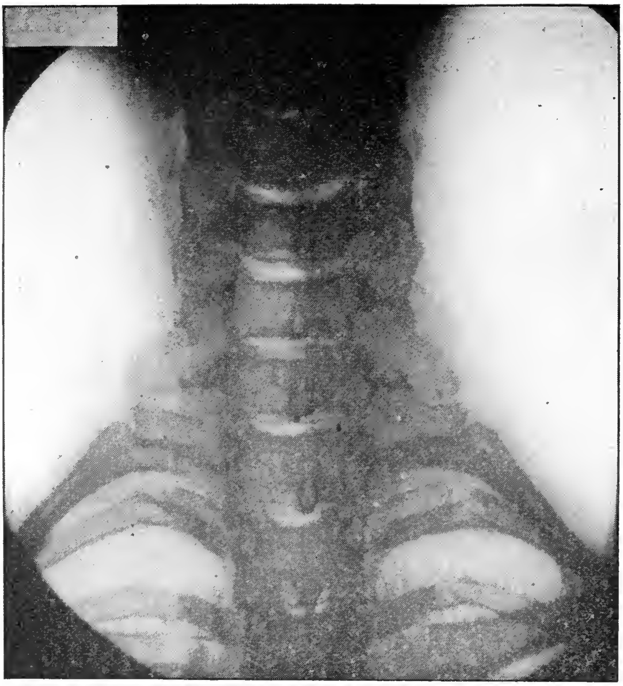

Fig. 4.—Miss J. H. Osteoarthritis cervical region. Large lateral processes of seventh cervical.

Pulmonary condition became so much worse very soon after treatments were begun that patient had to leave for sanitarium.

Such clinical and x-ray findings, however, in a case with eye symptoms are quite usual and strongly suggestive, in the light of other cases, that the connection is more than imaginary and it is mentioned to call attention to that fact rather than as an end-result.

Case 9. Miss O. W. Referred to us by Dr. Kelsey on October 25, 1920, because of her recent development of eye-strain symptoms and pain and tenderness in neck, made worse by eye work of any kind—often "has to hold head while writing or reading"—uses a small pillow under her neck while resting.

The salient facts in her examination were as follows: Undernourished type—generally relaxed posture—relaxed sacroiliac joints—sensitive to pressure over left suprascapular region—fibrous crepitation over posterior processes of fifth, sixth and seventh cervical vertebrae elicited by palpating finger—stands in a very flat back position—left shoulder

FIG. 5.—Miss T. Cervico-dorsal scoliosis with infringement of lateral process of seventh cervical.

higher than the right — moderately flexed scapulae. Diagnosis: Generally relaxed posture; subscapular bursitis. Treated by corrective shoes and high-backed, back-lace corset with shoulder straps, baking and massage, and mild stretching.

Patient reported on January 14, 1921, "greatest relief from lessening of tension which she formerly felt when reading, or looking at scenery or a moving picture."

Following report received from Dr. Kelsey, February 24th, 1921: "In the case of Miss O. W., I find that the esotropia has fallen from 15° prism to 10° for distance, and at times the diplopia for the near point is controlled, but there is in reality 10° esotropia at near point."

CASE 10. Mrs. K. Entered February 8th, 1921. Wife of a San Francisco physician, who referred her to Dr. Mills and myself because of a paretic condition of the pupil of the left eye, which condition began two years ago after a period of intensive piano practice of four hours a day.

Case had been diagnosed as encephalitis, but husband couldn't agree with that diagnosis.

Ocular examination found "no faults in vision and the pupillary condition probably due to sympathetic irritation."

Orthopædic examination showed moderate static faults — one-half inch short leg — long, round back — drooping shoulders, with heavy breasts — marked crepitation under upper inner angle of scapulae, worse on left, and palpation discovered flexed scapulae with marked sensitiveness to deep pressure throughout the region of the superior angle of the left scapula, extending toward the seventh cervical. The x-ray showed rather large lateral processes of seventh cervical, unequal on the two sides. Diagnosis: Subscapular bursitis.

Treatment began with massage and relieved at first, but within a week pain became worse and adhesive strapping immobilizing the scapulae gave relief—correction of posture by shoes, corsets and special brassiere.

The especial point of interest thus far is that under rest the pupils become equal.

OPERATION FOR HYPERTROPHIED PATELLA.

BY GEORGE E. BENNETT, M.D., BALTIMORE, MD.

Hypertrophied patellae are most often the result of comminuted fractures that have united firmly with a marked increase in the length and breadth, but not infrequently they are the result of a vigorous manipulation of the knee with a resulting fracture of the patella at the attachment of the patellar tendon. The small fragment that is separated unites in a position that increases the length of the patella. Infections, such as primary osteomyelitis and osteomyelitis secondary to patellar bursal infections, and severe strains also cause the condition.

Fortunately the enlarged patella seldom gives any annoying symptoms. The usual signs are the increase in length and breadth of the patella, a knee that is somewhat limited in flexion, but is a painless and well-functioning joint. However, one does see individuals, who have a disabled and painful knee with marked synovial thickening, which is the result of constant trauma from a patella that is too long and broad. This type also has a considerable loss of function, particularly the inability to flex the leg beyond seventy or eighty degrees without pain, having a great deal of discomfort when attempting to go up and down grades and walking up and down stairs. The symptoms will all disappear under rest, to recur with use.

Many such cases have been operated on and the thickened synovial membrane removed with temporary relief of symptoms. The writer has had several such experiences, but obviously any procedure of this type is palliative surgery, as we in no way remove the cause and may expect a recurrence of signs and symptoms. Inasmuch as the enlarged patella is the cause, we have attempted to develop an operation which will reduce the patella to its normal size, and the results have been very satisfactory.

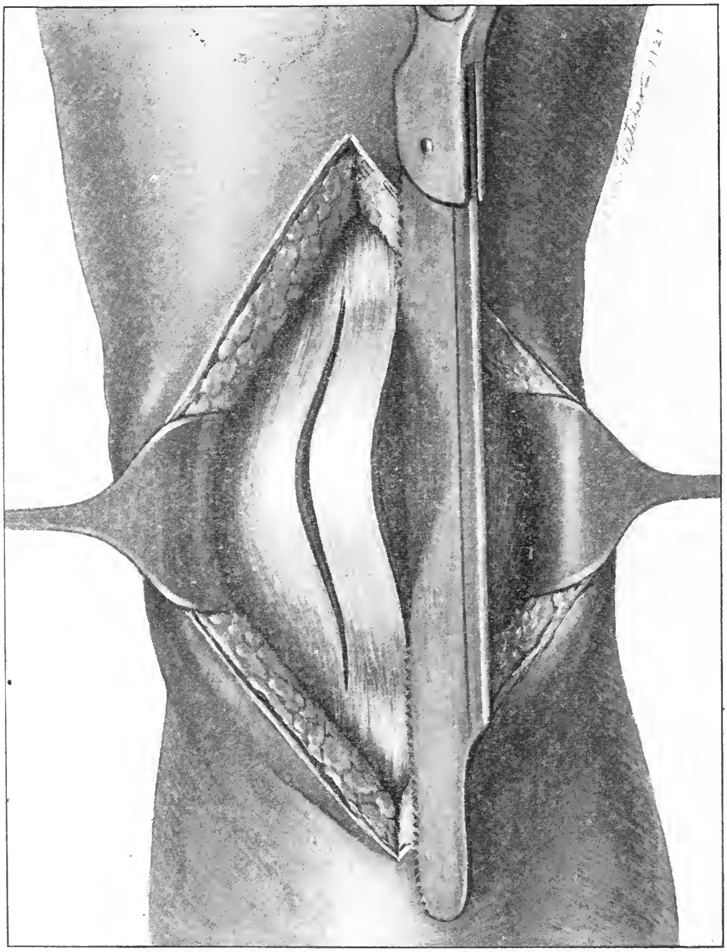

Fig. 1.—Exposure by linear incision extending from the midportion of the patellar tendon over the patella and exposing the attachment of the quadriceps. The central section of the patella to be removed is marked by a scalpel, and with a thin saw is cut three-fourths of its depth. At this depth the patella can be "cracked" by an osteotome, or, as shown in the cut, by lateral pressure on the saw blade. This detail of technique prevents small particles of bone entering the joint.

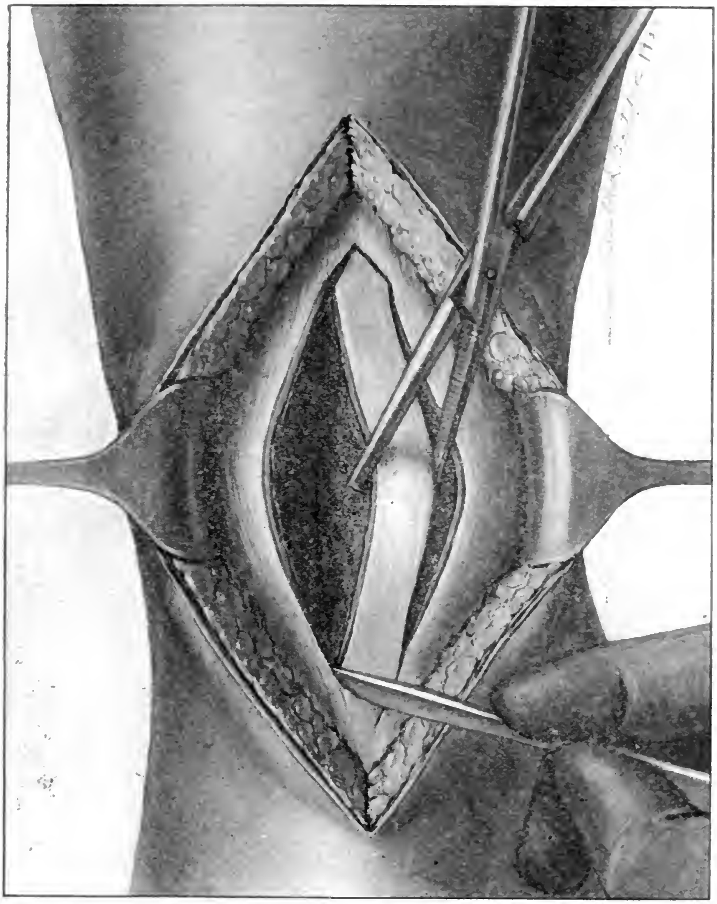

FIG. 2.—Removal of central portion. A V-shaped cut in patellar and quadriceps tendons insures easy closure.

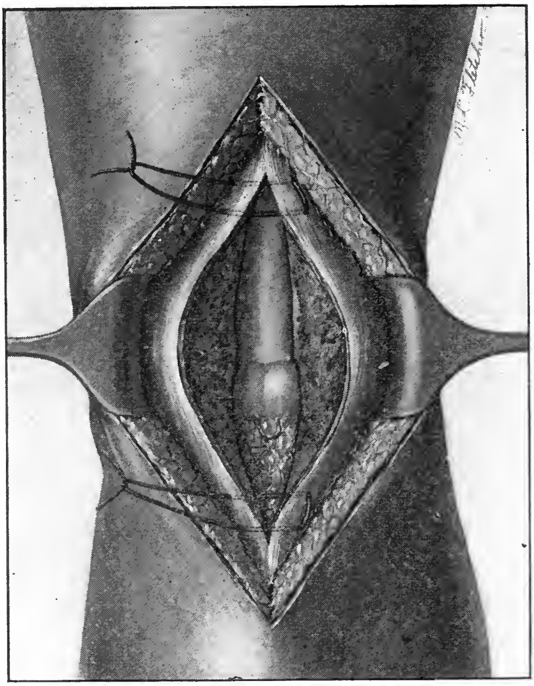

Fig. 3.—Mattress sutures of heavy kangaroo tendon in the patellar and quadriceps tendons.

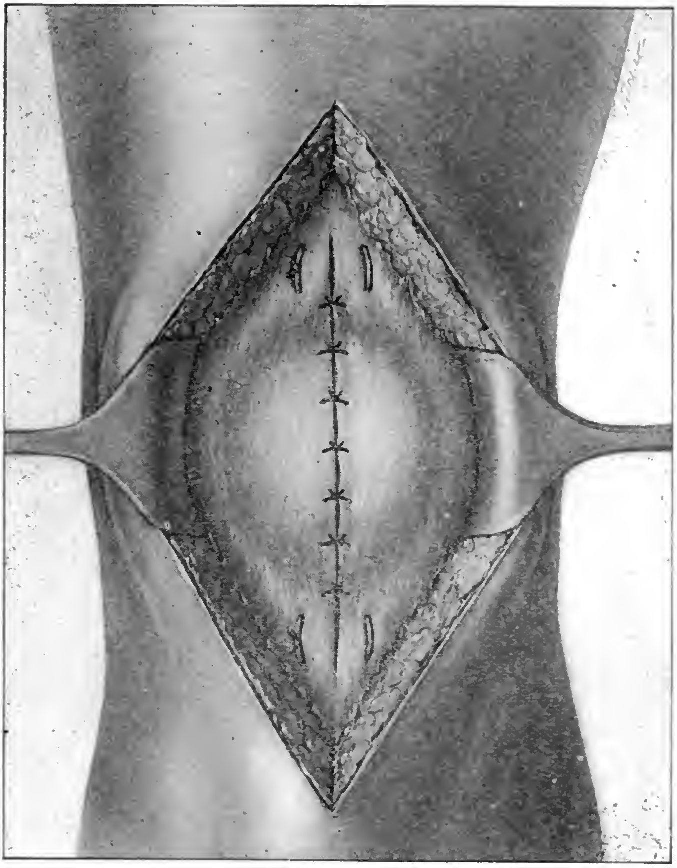

FIG. 4.—Chromic catgut to close fasciae over the patella. It has not been found necessary to place any suture through the patella.

Post-operative treatment: Leg immobilized in full extension for two weeks; active and passive exercises the third week, and patient permitted to walk at the end of the third week.

X-Ray A.—Old fractured patella with hypertrophy, giving marked symptoms, which was operated on successfully.

X-Ray B.—Old injury and fracture of patella in young individual, producing marked synovial irritation. Was operated on successfully.

A detailed case report is unnecessary. The operation has been in use several years and is satisfactory. The accompanying illustrations show the two types of cases that have been operated upon with satisfactory results.

A CLINICAL AND EXPERIMENTAL STUDY OF THE FREE TRANSPLANTATION OF FASCIA AND TENDON.

BY W. E. GALLIE AND A. B. LE MESURIER, TORONTO, CAN.

THE transplantation of fascia and tendon for the repair of various anatomical defects has been recognized for some years as a useful surgical procedure. Experiments by numerous investigators have shown that when the fibrous tissues are cut free from their circulation and transplanted to another position in the same animal, they may be expected to survive the operation and retain their normal gross and histological characteristics. The principle has never come into general use, however, owing to the variability of the firmness with which such transplants heal to the surrounding tissues. It was with the object of overcoming the uncertainty of the results obtained in these operations that the research referred to in this paper was undertaken, and we are now in a position, after a thorough clinical test of the principles involved, to report definite progress towards making the transplantation of the fibrous tissues a more valuable addition to operative surgery.

A preliminary report of the experimental investigation has already been published,[1] but it will be necessary, before referring to their clinical application, to review briefly the results of our research. Our attention was directed, in the first place, to the simple healing of the fibrous tissues. Under the name of fibrous tissues are grouped tendon, fascia and aponeurosis, which are essentially the same kind of tissue. They consist of wavy parallel lines of heavy white fibres between which are situated a few flattened cells (tendon-cells). In tendons the fibres are grouped into stout cords, while in fascia and aponeurosis they are arranged in thin sheets. In all three the surfaces are covered with a delicate areolar tissue in which the blood-vessels ramify. The fibres are divided into irregular bundles by processes of this areolar tissue which extend inward from the surface and carry minute blood-vessels and lymphatics to the deeper parts.

Experiments were performed in which transverse and longitudinal incisions were made in fascia, tendon and aponeurosis, and closed with absorbable and non-absorbable sutures. In some the edges of the fibrous

tissue incised were simply brought into close apposition; in others the edges were overlapped. The specimens were recovered at weekly intervals up to several months. In the early stages the area of the operation shows an ordinary inflammatory reaction. The blood-vessels, which run in the areolar tissue on the surface of the fascia or tendon, are engorged and the tissues are covered with a plastic exudate consisting of fibrin, cells, and serum. At the end of two weeks the process of repair is at its height. The exudate has become filled with proliferating connective-tissue cells and leucocytes, and the growth of new blood-capillaries has converted it into a granulation tissue. It would appear that the tendon-cells and fibres take little or no part in these proliferative changes, and that the new connective-tissue cells are derived from the areolar membranes on the surface, and in the interstices between the groups of fibres. At the end of three to four weeks the cellular activity has subsided and the line of the incision is filled with delicate irregularly-arranged branching fibres. As time goes on the fibres become thickened and the cells and new-formed blood-vessels largely disappear. When the process is completed the sheath on the surface has been restored to normal and the line of the incision is healed together by ordinary connective tissue.

These observations in regard to the character of the healing in the line of the incision are of great importance from a clinical standpoint. They explain the uncertainty which attends the healing of tendons after subcutaneous tenotomy, and the frequency with which the abdominal aponeuroses separate after edge-to-edge suture for the cure of ventral hernia. If the repair of wounds in these structures is to depend on such material as areolar and scar tissue it is only natural to expect that if the line of union is subjected to severe degrees of strain, the edges of the wound will gradually separate. In many of our experiments this actually occurred, particularly when absorbable sutures were employed. It occurred frequently, however, even when silk or linen was used, owing to the cutting out of the sutures. This tendency to separate was considerably reduced by overlapping the edges of the incised fascia or aponeurosis, as is done in the ordinary operation for ventral hernia, and by making a step-tenotomy in the case of tendon. By this means the area of the healing surface was enlarged and the amount of areolar or scar tissue forming in the line of union correspondingly increased. In order that this overlapping method may be at all effective, however, it was found that the surfaces placed in contact must be completely deprived of their sheath of areolar tissue, otherwise the strength of the

union will be very slight. Such surfaces should be thoroughly scraped and scarified in order that when healing does occur the new connective tissue may have a deep grip among the fibres. The importance of these observations is well demonstrated by the uniformity of the success which attends step-tenotomies, and by the frequency of the failures which result from attempts to make side-to-side sutures of severed tendons. They indicate that in all operations in which it is intended to unite any of the fibrous tissues, these tissues must be placed in actual contact with each other over a sufficient distance to make certain that the connective tissue, which forms in the line of union, will be sufficiently strong to withstand the anticipated strain. This means that, in the case of aponeurosis and deep fascia, the edges should be overlapped, and in the case of the tendons, when tenotomy is performed, some form of step-operation should be employed. In the implantation of tendons into one another it is essential that raw surfaces shall be brought together, and this is the best accomplished by some method in which a portion of the split end of one tendon is passed through an incision in the other, or in which they are actually woven together as in the splicing of a rope.

FIG. 1.—Method of Healing of Tendon to Bone. (1) Tendon, consisting of regular parallel fibres. (3) Bone, and (2) New-formed scar tissue, consisting of irregularly arranged fibres uniting the two.

Our investigations also included a study of the healing of tendon to bone. Some years ago we described a method of converting the tendons of paralyzed muscles into ligaments which would prevent the occurrence of deformities.[2] Since the introduction of this method surgeons have frequently reported to us that the new ligaments have pulled out of their beds in the bone and that the deformities have recurred. In our own earlier cases this did happen occasionally, but after we realized the nature of the union which can be expected between tendon and bone, the failures from this cause were soon eliminated. The healing of tendon to bone takes place in precisely the same way as the healing of tendon to tendon, that is, by the formation of new connective tissue which adheres to both tendon and bone (Fig. 1.). If the tendon is placed in its bed, without the removal of the areolar membranes, the fixation can be no stronger than are these areolar membranes. Naturally the tendons will pull out. To make certain of a solid fixation it is necessary to scrape and scarify the tendons until actual contact with the walls of the trough in the bone is assured, and we have found that if the tendon is split so that its raw surface comes in contact with bone, and if this contact is provided for over sufficient length of surface, the fixation will withstand any degree of physiological strain. These observations indicate the unwisdom of depending, in tendon-transferences, upon suture of the end of the tendon to periosteum or laying it in a short groove in the bone. The only safe method of fixation consists in passing the scraped or split end of the tendon through a suitable hole in the bone and fastening it in place until complete healing has occurred.

With these facts established, in regard to the simple healing of the fibrous tissues, we proceeded to a study of the healing of transplants. Our experiments corroborated those of previous investigators in showing that, when fascia, tendon or aponeurosis is transplanted in the same animal, it will continue to live practically unchanged. If the transplanted tendon is very thick the central portions will degenerate, which indicates that, if the nature of the operation requires tissue of the strength of thick tendon, the transplant should be freely incised or split, in order that the lymph may reach its deeper parts. These transplants heal to the surrounding tissues in quite the same way as do the fibrous tissues whose circulation has not been disturbed. The line of union becomes filled with new connective tissue, and over the whole area of the operation grows a new areolar film which closely resembles the normal sheath. It is thus apparent that transplants of fascia, tendon,

and aponeurosis can be used successfully to fill defects in the fibrous tissues, but that the method of healing will be quite as unreliable as when they are closed by simple suture. This was demonstrated in numerous experiments in which gaps in tendon were bridged with tendon or fascia, and in which patch transplants were introduced into defects in fascia or aponeurosis. Quite frequently the connective tissue in the line of union stretched and so allowed the effectiveness of the operation to be destroyed.

As the occasion for using transplants of the fibrous tissues usually arises in conditions in which considerable strain on the part is anticipated, it is evident that, to make the method effective, some more certain means of securing firm union must be discovered than that provided by edge-to-edge suture. Even the precaution of scraping the areas which are in contact, and overlapping the edges, is not sufficiently trustworthy when one considers that the whole outcome of these operations depends on the firmness of the healing. When one wishes to unite the transplant to bone, the problem is not so difficult, for here it is only necessary to follow the principle already enunciated, namely, to bury the scarified or shredded end of the transplant in a long tunnel in the bone. But in the case of large defects in aponeurosis or tendon, such as occur in wide ventral hernias, or in wounds or burns involving tendons, the outlook is not so certain. It is just in these particular cases that the transplantation of fascia and tendon has so frequently failed and so earned an unwarranted disrepute. In an attempt to solve this problem we did a series of experiments in which strips of fascia were removed from the animal's back and then carried transversely across the gap so produced and woven several times into the edges. At each of the slits through which the transplant passed, catgut or linen sutures were inserted. This method proved to be a great improvement on edge-to-edge suture, and also on the method of overlapping the margins. It had the disadvantages, however, that it was a tedious operation to perform, and also, that it did not completely exclude the possibility of stretching of the connective tissue in the line of suture. The trial of the method, however, led to an idea which has completely solved the difficulties in the way of using the fibrous tissues as transplants, namely, the idea of threading the transplants on needles and using them as living sutures. By this means the transplant can be woven securely into the surrounding tissues and mechanically anchored so firmly into them that it is no longer necessary to depend upon the doubtful strength of the scar tissue. The surgeon now

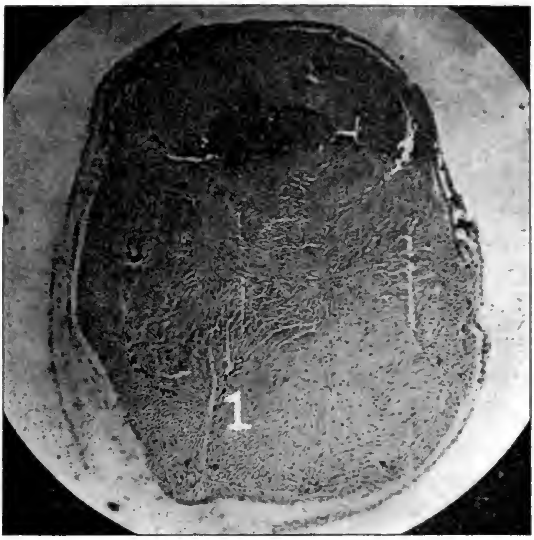

FIG. 2.—Cross-section of Fascial Suture after One Year. The suture is now a round cord closely resembling tendon. It consists almost solidly of parallel fibres, with a few vascular areolar-tissue trabeculae (1).

depends solely on the strength of the suture itself and of the tissues into which it is woven.

Before employing the method clinically we did a series of experiments in which gaps in fascia were fastened together with these living sutures. The specimens were recovered at weekly intervals and they showed that the sutures behaved exactly as did the transplants already described. They continued to live practically unchanged and healed to whatever structures they were woven into, by new connective tissue. At the end of the second week new blood-vessels could be seen with a glass, growing along the surface of the suture, and by the end of the third week they could be followed with the naked eye. In the succeeding weeks the primary inflammatory phenomena subsided and left the sutures as white rounded cords, which bridged the gap in the fascia and held its edges at the same distance from one another as at the time of the operation. Cross-section of specimens recovered in the early weeks showed the folds of the fascia separated by layers of areolar tissue, which were continuous with a similar layer which formed on the surface, but, as time went on, these new trabeculae contracted so that they were scarcely distinguishable, and the suture had the exact appearance of a sectioned tendon (Fig. 2.).

In order to test further the clinical value of this method we did one set of experiments in which the strength of the sutures was recorded, at various intervals, after the operation, and another in which the length of the sutures was accurately measured at the time of the operation, and again at the autopsy. These experiments showed that the strength of the sutures remained practically constant and that neither stretching nor contracture occurred after the transplantation.

From our experimental and clinical work a few points in technique have been elaborated which may prove of value. Our sutures are practically all made from fascia lata, which is very strong, and is plentiful. A long incision is made on the outer side of the thigh, and the fascia roughly cleared of fat and areolar tissue. Two small longitudinal incisions, a quarter of an inch apart, are made in the fascia, which is then ripped to the required length with a pair of scissors. As many sutures as are required are thus prepared without detaching the ends, and the skin drawn together over them until the field of the principal operation is completely prepared. One end of a suture is then cut free and threaded into a large-eyed needle and tied securely with catgut. This precaution is necessary as the sutures constantly tend to slip out of the needle. The suture is then lifted out of its bed and a catgut ligature tied about its terminal end. The needle is now passed through one of the structures it is proposed to sew together, and then through the terminal end of the suture. In this way a slip-knot is made, which, when drawn taut, provides a perfect anchor (Fig. 3, (1)). Sometimes we make doubly certain of the security of the anchor by taking another stitch with the needle and passing it through one of the parts of the slip-knot. The surgeon may now proceed with his sewing in the ordinary way, but it is usually necessary, owing to the slippery character of the suture, to make an occasional lock-stitch. This may be done by transfixing the suture with the needle after passing it through the edge of the gap, or better, by looping the suture into a single knot. (Fig. 3, (2 and 3)). When the end of the suture is reached it may be terminated at once or lengthened by fastening another suture to it. This latter is done in the same way as one fastens together two leather thongs or two lacrosse guts, as illustrated in the diagram. (Fig. 3, (5 and 6)). To terminate the suture we usually split the end which is attached to the needle into two strands, and tie these about the main suture in a tight knot. (Fig. 3 (4)). This knot is finally transfixed and tied with a ligature of catgut. These precautions are very necessary, as the knot has a marked tendency to untie and allow the suture to become loose.

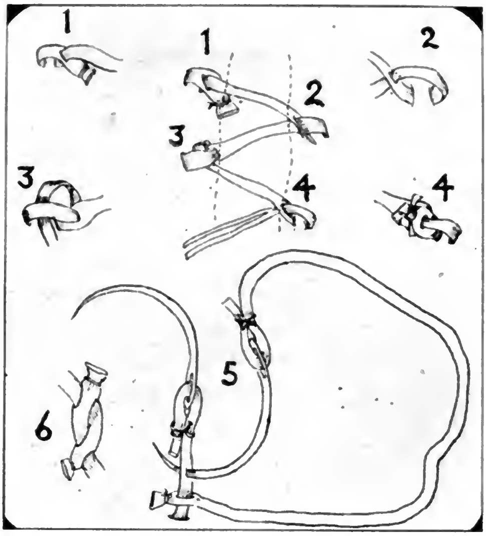

FIG. 3.—Technique of Insertion of Fascial Suture. (1) Method of starting the suture. (2) and (3) Method of preventing slipping at each insertion by either simple transfixion or by transfixion combined with a single knot. (4) Method of ending the suture by transfixing, splitting and tying both ends. This knot should be reinforced by a transfixion suture of catgut. (5) Method of uniting a fresh suture to one that has been expended. (6) Join completed.

The principles derived from this research have already been applied to a great variety of conditions in the realms of both general and orthopaedic surgery. In a general paper, such as this, it is impossible to do more than review these conditions briefly, and to leave to other publications the exact description of the operations performed. Something may be said, however, to indicate the way in which the method can be applied to the various fields.

Some years ago we had several cases of hallux valgus in which the deformity was so severe that we had little hope of being able to prevent its recurrence. One had already been operated upon and the abduction of the toe had recurred so badly that the patient had returned with a request that we make an attempt to correct it. In these cases we removed a strong strip of the extensor proprius hallucis tendon and passed it through holes in the base of the first phalanx and the neck of the first metatarsal so that it formed a new internal lateral ligament. The deformity was corrected and the ligament drawn taut and fastened with catgut. Nine years have now elapsed since the first operation was per-

formed and in no case has the valgus recurred. Such an operation is, of course, quite unnecessary in the great majority of cases of hallux valgus, but for those extreme cases in which the great toe lies transversely across the others it offers a sure method of restoring the foot to something more nearly normal.

Recurring lateral dislocation of the patella is a condition for which many operations have been devised, but which frequently eludes all our efforts to overcome it. In the autumn of 1917 a soldier came into our wards with such a dislocation, for which a plication of the capsule had already been tried unsuccessfully, and his disability was such as to render him totally unfit for service or for earning a living. In this case an operation was performed in which the patella was forced back into its correct position, and tethered there by a heavy new ligament, which was obtained from the tendo Achillis of the same side. This ligament was passed through a hole placed transversely through the patella, and then through a hole in the internal condyle, which was so placed that it lay in the centre of the circle through which the patella described its arc of motion during flexion and extension. The tendency of the patella to spring back to the lateral aspect of the thigh was so great that it had to be held in place till the plaster had been applied and then fixed by moulding the plaster against it. It is now nearly five years since this operation was performed, and except for a preliminary two months after the removal of the plaster, during which time he received massage and remedial exercises, the patient has been working steadily at his trade. I saw him in May of last year, and he has no disability whatever and the patella is in normal position. The new ligament can be seen and felt passing from the patella to the internal condyle.

We have used segments of the tendo Achillis as transplants in a variety of conditions and in no case has any disability of the leg resulted. After the removal of the transplant the sheath is carefully closed, and when two months have gone by the tendon appears to be as strong as ever.

This type of operation has been performed also by Dr. Starr in a case of recurring dislocation of the patella in a young girl. He used a strip of fascia lata as the new ligament, and the result was equally satisfactory. Fascia lata is the ideal tissue for transplantation, unless the anticipated strain is very great, as in laboring men.

About eighteen months ago a man came to us with a rupture of the ligamentum patellae produced by a severe fall against a radiator. He had been splinted for several months but without union of the liga-

ment. We saw him a year after the accident, walking like a man with an artificial leg, with no power to extend the knee. In this case we made a new ligamentum patellae from two thick strands of his tendo Achillis. These were passed through holes bored longitudinally through the patella, and carried down to the tubercle of the tibia, where they were again passed through holes in the bone. The patella was drawn down to near its normal position and the new ligaments stitched to the periosteum of the patella and tibia with catgut to hold them in correct position till healing could occur. This patient made an excellent recovery and is now engaged in his regular occupation as a bricklayer. Since then, another similar case has been operated upon with an equally satisfactory result.

The success of this operation led us to try a similar plan with a case of non-union of the patella in which the lower fragment was so small that we had little hope of satisfactory bony union. The fragments were freshened and drawn together in the usual way with kangaroo tendon, and the ruptured periosteum closed with catgut. A heavy strip of fascia lata was passed from above downward through holes in the two fragments, then transversely through the ligamentum patellae, and back through similar holes in the fragments, and stitched together at the upper border of the patella. The result in this case was perfect and the patient has complete use of the limb. We were so impressed with the appearance of this case at the time of the operation that we have decided to use the principle in all cases of non-union of the patella, whether we can get the fragments together or not. Even when the freshened surfaces of the bone can be brought together the result is always in doubt, and it seems to us preferable to make certain of a good functional result by this means, rather than to run the risk of a complete failure of the operation. We would recommend, however, that tendo Achillis be used instead of fascia lata in heavy or powerful persons.

The principle as applied to making new ligaments has been used in various other ways. On several occasions we have done arthrodeses of the mid-tarsal joints in small children and fastened the bones together with strips of tendon with the idea of securing a functional result should the arthrodesis fail. Similarly, in doing astragalectomy for calcaneo-valgus, we fasten the external malleolus forward by fixing a strip of the peroneus brevis into the external malleolus. One of the causes of failure in this excellent operation is that after the patient begins to walk the locking of the navicular bone against the lower end of the

tibia produces so great a leverage that frequently the external malleolus gradually slides backwards and the patient ends up with a calcaneovarus deformity. This can be prevented by the simple precaution of making a strong new ligament which will prevent the posterior displacement of the malleolus.

In the preliminary portion of this paper we have already outlined the principles which we believe should govern the technique of uniting one tendon to another. Many a tendon inplantation has failed owing to pulling apart of the two tendons or stretching of the connective tissue which forms between them. Some have overcome this difficulty by using silk or linen sutures, but in our experience this expedient is not satisfactory, as in a certain percentage of cases the sutures will set up sufficient irritation to produce sinuses weeks or months after the operation, which will persist until the foreign material is discharged or removed. This difficulty can be avoided by dispensing with the non-absorbable sutures, and by weaving the tendons into one another with raw surface to raw surface, and fixing with fine catgut. If this is done thoroughly the healing will be sufficiently firm at the end of three weeks to allow gentle movement.

When gaps in tendons are to be bridged, transplants of tendon or fascia make ideal material for the operation. When used in the ordinary way, however, that is, by end-to-end suture, or overlapping suture of strips or tubes of fascia or of pieces of tendon, the result is very uncertain as the line of suture is apt to open up. We got over this difficulty at first by splicing the transplant into the ends of the tendon, and the method proved quite successful, but since the idea occurred to us of threading the transplant on a needle the operation has been much simplified and improved. The narrow strip of fascia is now woven backwards and forwards across the gap and into the ends of the tendon with whatever tension the retraction of the muscle appears to require, and is finally anchored by a catgut ligature. Active movements may be begun early without anxiety as to the healing of the suture and without fear that the ends of the tendon will ultimately stretch apart.

Living sutures of fascia and tendon are useful in other ways. About a year ago we applied the method to a case of infantile paralysis involving the shoulder and arm. The deltoid, supra- and infraspinatus, biceps, brachialis anticus, and triceps were completely paralyzed, and the pectorals and latissimus dorsi had only a little power. The shoulder-joint could be dislocated at will. The forearm and hand, however, were perfect, and the presence of a strong trapezius made us hopeful

that the child's condition might be improved by a muscle transplantation. In this case we placed the arm in a position of 45° abduction and fastened the acromion to the greater tuberosity of the humerus by strips of fascia lata passed backward and forward through each. The central portion of the trapezius was then raised from the acromion along with the periosteum into which it was inserted, and sutures of fascia lata woven into it. These sutures were carried over the head of the humerus and fastened into holes bored in the bone at the insertion of the deltoid. The patient is now able to abduct the arm to nearly 45° and by so doing can carry the hand to the mouth by contracting the muscles of the forearm. A reconsideration of this case has convinced us that the transplantation of the central portion of the trapezius muscle was an unnecessary step in the operation. While the patient is able to abduct the arm from the side to practically the angle at which it was placed during the operation, she does so by rotating the scapula. It seemed to us likely that a similar result could be obtained by the very simple operation of suturing the acromion to the greater tuberosity of the humerus with stout strips of fascia lata. Recently we had an opportunity to test the soundness of our conclusion in another patient suffering from a similar paralysis. In this case the shoulder was fastened at an angle of 60° with the body, as this angle is preferable, and the resulting improvement has been remarkable. This patient is able to abduct the arm freely and even get his hand to the top of his head, and owing to the presence of slight power in the pectoralis major and latissimus dorsi, he has practically a normal range of antero-posterior motion.

The principle of living sutures has proved of value in other conditions which must be considered as belonging to general surgery. The chief of these is hernia, particularly direct inguinal hernia, and large ventral hernia. We have had an excellent opportunity to test its value among soldiers who have returned to hospital because of the failure of previous operations. In our series of fifty cases there has not been a single recurrence over a period of three years. This amply proves the strength and durability of the suture and the value of the method of inserting it.

This short review of our cases will serve to indicate the many fields in which the transplantation of fascia and tendon may be of value. That it has never become popular in the past is due, we believe, to failure to observe the principles which govern the process of repair, and

with these principles fully understood it is a simple matter to ensure a high percentage of successes. There appears to be no good reason now for ever employing silk for ligaments, tendons or buried sutures, nor is it necessary to take the risk of failure by trusting to the uncertain healing of fibrous structures which have been simply fastened together with catgut or other absorbable material. It is obviously more rational to use as ligaments, tendons, or sutures, material which we know will live and retain its normal characteristics. Before reporting the results of our experiments and clinical investigations we have given the methods described most careful study in the laboratory, and have allowed the lapse of time to test the permanence of the clinical results, so that we feel that we can safely recommend them for general surgical use.

REFERENCES.

[1] Canadian Medical Association Journal, July, 1921.
[2] Annals of Surgery, March, 1913; Jour. Am. Orth Assn., January, 1916.

News Notes

Dr. W. Eugene Wolcott, of Omaha, has sailed for Europe, to spend the summer studying in the clinic of Sir Robert Jones, and to observe orthopaedic work being done in various centers of Austria, Belgium, France, and Italy.

The combined meeting of the Interurban Orthopaedic Club and the Eastern States Orthopaedic Club was held in New York on March 31st and April 1st. Dr. Clarence L. Starr, as Honorary President of both clubs, presided at the executive sessions and acted as toastmaster at the dinner held at the New York Athletic Club.

Of special interest were Dr. Clark's and Dr. Bancroft's most suggestive observations on repair of bone, indicating how very far we are yet from complete understanding of bony processes and the exact functions of the various cells having to do with bone growth and destruction.

Following the luncheon on Saturday, a most interesting discussion on the subject of pay clinics was opened by Dr. Wilson of Cornell Medical School. Their success with the pay clinic seems assured.

Dr. Van Buren, representing Dean Darrach of the College of Physicians and Surgeons, outlined in a most interesting way the plans for the new and large development of the Medical School by Columbia University.

The Graduate Department of Hygiene and Physical Education of Wellesley College makes the following announcement in its Bulletin for the coming year:

"A strictly limited number of graduate scholarships are open to students in the Department of Hygiene and Physical Education. These are open to students only in their second year and are awarded for unusual promise in research or teaching power.

"Research fellowship of one thousand dollars for the study of Orthopedics in Relation to Hygiene and Physical Education.

"General requirements to be met by the successful applicant: good health; the Bachelor's degree from a college or university of good standing; sound preparation in chemistry, physics, and biology; special preparation in anatomy, kinesiology, and physiology; familiarity with the elements of orthopedic theory and practice; and an insight into some one or more of the problems of orthopedics as related to hygiene and physical education.

"The work on the problem chosen in consultation with the department must be done in residence at Wellesley College except for study and observation of

clinical practice. It will, in general, begin in September following the acceptance of the applicant and will continue through one calendar year. It will involve kinesiology, applied physiology, and the study of clinical material. For the latter, opportunity will be provided to study the work of orthopedic surgeons in Boston and other eastern cities. The results of the investigation are to be embodied in a thesis to be submitted to the department and published.

"Those wishing to apply for this fellowship should send their evidence of preparation and qualifications to the Director, Graduate Department of Hygiene and Physical Education, Wellesley College, Wellesley, Mass. The decision reached by the department will be based upon the applicant's record, upon personal correspondence, and when possible, upon personal interviews."

The Robert Jones Orthopaedic Society held its Spring meeting in Boston on April 21st and 22nd, under the honorary presidency of Dr. Robert B. Osgood. The Society is composed of men practising orthopaedic surgery in the cities along the eastern coast of the United States and Canada. Two new members were elected, Dr. Alan DeForest Smith, of New York, and Dr. W. A. Cochrane of Boston.

The morning of the first day of the meeting was spent at the Orthopaedic Ward of the Massachusetts General Hospital, with the following programme: Ward Visit, Dr. R. B. Osgood; "Congenital Dislocation of Hip," Dr. Z. B. Adams; "Treatment of Hand Injuries," Dr. W. A. Cochrane; "Scoliosis," Dr. Armin Klein; "Tennis Elbow," Dr. R. B. Osgood; "Separation of the Upper Femoral Epiphysis," Dr. Albert Key; "Sacro-Iliac Arthrodesis," Dr. M. N. Smith-Petersen; "Low Back Pain," Dr. P. D. Wilson; Out-Patient and Ward Visit with the Fracture Service, Dr. D. F. Jones.

In the afternoon the programme was as follows: "Arthritis," Dr. L. T. Swaim, Robert B. Brigham Hospital; "Reconstruction Surgery," Dr. Frederick Cotton, Boston City Hospital.

On Saturday morning the Society visited the Children's Hospital, with the following programme: Ward Visit, Dr. R. W. Lovett; "Birth Injuries of the Central Nervous System," Dr. Bronson Carothers; "Poliomyelitis," Dr. A. T. Legg; "Obstetrical Paralysis," Dr. J. W. Sever; "Operation for Club-Foot," "Incision for Drainage of Hip," Dr. F. R. Ober.

The American Orthopedic Association held its annual meeting in Washington on May 1st to 3rd, with Dr. Nathaniel Allison of St. Louis as presiding officer.

Dr. Murk Jansen of Leiden was the guest of the Association and added greatly to the value of the meeting by his scholarly and philosophical discussion of the subjects presented.

At the annual dinner, Senator Spencer of Missouri, General McCaw and the Reverend Mr. Freeman of Washington were the speakers.

Dr. R. R. Fitch, of Rochester, N. Y., is the President of the Association for the coming year.

Plans have been made and approved by the Ancient Order of the Mystic Shrine for five hospitals for crippled children in the cities of St. Louis, San Francisco, Shrevesport, Montreal, and the Twin Cities of St. Paul and Minneapolis.

In St. Louis, Dr. Nathaniel Allison has been appointed Chief of Staff, and a temporary contract made with Washington University, breakable by either party in six months, for the Hospital to be staffed by Dr. Allison and the Faculty of the University.

In San Francisco the Chief Surgeon will be Dr. Walter I. Baldwin; in Shrevesport, Dr. Guy A. Caldwell; in the Twin Cities, Dr. Wallace H. Cole; and in Montreal, Dr. A. Mackenzie Forbes.

In view of their appointment as Chief Surgeons, Dr. Allison and Dr. Forbes have resigned from the Advisory Board of the Shriners' Hospitals for Crippled Children, and Dr. W. E. Gallie, of Toronto, and Dr. Edwin W. Ryerson, of Chicago, have been appointed in their stead.

The summer meeting of the British Orthopaedic Association was held at Alton on Friday and Saturday, May 26th and 27th, 1922.

On the first day of the meeting a visit was made to Sir William Treloar's Hospital for Crippled Children, where a demonstration of cases was given.

Of interest to orthopaedic surgeons travelling abroad this summer is the announcement from Dr. Calot of a course to be given at Berck-Plage from the 7th to the 13th of August. Detailed information regarding the course may be obtained from Dr. Fouchet, Institut Calot, Berck-Plage (Pas de Calais), France, or from Dr. Colleu, Clinique Calot, 69 Quai d'Orsay, Paris. The course, which is intended both for physicians and students, will be given in English and Spanish, as well as in French, and will include instruction in the subjects indispensable to the practice of orthopaedic surgery, with actual demonstrations of treatment.

Current Orthopaedic Literature

TUBERCULOSIS.

Early Diagnosis and Treatment of Joint Tuberculosis. J. T. O'Ferrall. *Southern Medical Journal,* February, 1922.

The point is made in this paper that the average practitioner does not use sufficient care in making a diagnosis of tubercular joint disease, and that there is not enough uniformity of opinion as to the best treatment for this condition. Rest, general hygienic surroundings, freedom from weight-bearing, and heliotherapy are urged.—*Edward S. Hatch, New Orleans.*

Tuberculosis of the Upper Extremity: Research Statistics on 86 Cases of Istituto Rizzoli (Prof. Putti). Giovanni Valtancoli. *Chir. degli Org. di Mov.,* Vol. 5, No. 6, December, 1921.

In comparison with the lower extremity, the number of cases of tuberculosis of the upper is rather small. The author's statistics contain 86 cases, divided as follows: 17 cases of tuberculosis of the shoulder joint and scapula; 41 cases of tuberculosis of the elbow, and 28 cases of tuberculosis of the wrist.

1. Tuberculosis of the shoulder. 17 cases, or 19.7 per cent. of tuberculosis of all joints of the upper extremities. It is decidedly rare in the first decade, only one case of that age being recorded. It is much more frequent in the second decade, which figures with 8 cases in this series.

Tuberculous heredity was found in 23.5 per cent. Other localizations, either pulmonary or bony, were recorded in 41.2 per cent. of the cases. Trauma was not found to be of etiological importance, being recorded in only 2 cases. Symptoms: The symptoms vary somewhat, according to whether one is dealing with the dry form (caries sicca) or with fungus form with formation of abscesses.

In the first group, there is always considerable atrophy of the shoulder region, the atrophy involving principally the deltoid and other neighboring muscles of the scapular girdle. The pain is intense, sometimes occurring spontaneously, but more often provoked by movement of the shoulder. The active motion of the shoulder is very much limited, and a peculiar grating is noted.

In the fungus form, the formation of abscesses, swelling of the joint, the production of fistula, and the very considerable atrophy of the arm are principal symptoms.

Of these cases, 23½ per cent. belonged to the dry form, and 76 per cent. to the fungus form of shoulder tuberculosis. The seat of the disease was more often in the humerus: only in one case was the lesion situated in the scapula

alone. Results: Of 17 cases, 8 were treated surgically. Of these 8, 7 were resected totally, and one partially. Nine cases were treated by immobilization in removable plaster cast and by heliotherapy.

The immediate result of the cases operated upon was good. Only one case returned after 6 years on account of the recurrence of pain in the articulation.

In all cases treated conservatively, all showed a regression of the morbid process, although there was more or less functional impairment, due to the limitation or total abolition of motion.

2. Tuberculosis of the elbow: 41 cases, or 47.7 per cent. All cases were unilateral. In regard to the age, the greatest number involved the 3rd quinquennium. Heredity was found in 7 cases, or 17 per cent. Other tuberculous manifestations were found in 18, or 43.9 per cent.

Trauma as etiological factor was established in 9 cases, or 21.9 per cent. Symptoms: The symptoms were essentially those generally found in chronic tuberculous arthritis: tumor, limitation of motion, fixation in semiflexion, tenderness, which was very slight on rest and very decided on motion, and, finally, very considerable muscular atrophy. There was a considerable tendency to formation of sinuses.

Pathology: In the 9 cases which were resected the ulna was most frequently involved, especially the sigmoid cavity. Only in 1 case was there an isolated lesion of the olecranon. The humerus was involved in 4 cases and the radius in 2. Ten cases, or 25 per cent., showed 1 or more sinuses.

Results: Cases treated surgically, 11; of these, 8 were totally resected, 1 was partially resected, 1 was treated by arthrotomy, 1 by amputation. Cases treated by immobilization in plaster-of-Paris cast together with heliotherapy, 30.

On the whole, the result of the treatment was satisfactory. In the cases resected, a solid ankylosis was obtained. None of the cases operated upon returned to the Institute on account of recurrence of symptoms.

Especially good functional results were obtained by partial resection of the olecranon in cases of extra-articular focus. The cases treated conservatively required on an average 2 years for their cure. Of 10 cases in which late results were obtainable, 7 had ankylosis, while in 3 a partial movement of the elbow remained. None of the cases died.

3. Tuberculosis of the wrist: 28 cases, or 32.5 per cent. Two of the cases were bilateral. Tuberculosis of the wrist is by far most frequent in the young, especially in the first infancy. The greater number of cases was found in the first decade (9 cases). Next came the second decade with 7 cases.

In only 2 cases tuberculous heredity was established. In 12 cases, or 42.8 per cent., there co-existed tuberculous affections of other joints or glands or viscera.

Trauma was established in 6 cases, or 21.4 per cent. Symptomatology: The most prominent symptoms were gradual onset, slow course, progressive tumor formation, pain, and tenderness on motion, rapid increase of functional impairment, fusiform swelling of the wrist, with tendency to flexion. Sinus formation was frequent, being found in 6 cases, or 21.4 per cent.

Pathology: Four cases showed almost complete destruction of the bones of

the wrist and 2 of these also caries of the radial and ulnar epiphyses. In 1 case the involvement of the radius produced a tendovaginitis with rice bodies in the sheath of the long extensor of the thumb. In 1 case, there was an isolated lesion of the os magnum.

Results: In only 6 cases a surgical operation was performed, consisting in conservative resection of the articulation. The other 22 cases were treated conservatively with bivalve plaster casts, immobilized in slight dorsiflexion in a manner which permitted free play of the metacarpophalangeal articulations.

One case only ended in death, but this was due to a co-existing hip disease. In the other cases, the outcome was cure, although the majority of cases showed almost complete loss of motion in the wrist-joint. Of 6 cases which were seen several years later, in 2 the mobility of the wrist was preserved in a moderate degree, while in 4 the joint was completely stiff.—*A. Steindler, Iowa City, Ia.*

TRAUMATA.

Diagnosis of False Fractures of the Femoral Neck (Rachitic Coxa Vara). Bloch. *La Presse Médicale*, January 7, 1922, p. 26.

A condition is frequently observed (in children) simulating fracture of the neck of the femur, but which is in reality a traumatic coxa vara. The line which looks like a fracture is the conjugal cartilage, rendered more or less transparent by rachitis. The lesion may occur (1) near the trochanter with a bend in the neck near its base, the conjugal cartilage being wide and sometimes horizontal; (2) in the middle of the neck, where the cartilage is vertical and often bifurcated; (3) near the head, simulating an epiphyseal separation.

It may develop without trauma. This is proved by a series of roentgenograms of the hip of a child which show the lesion occurring in the middle of the neck after the patient had been in bed constantly for eighteen months.

It differs from pathologic fracture in that there is no over-riding of the fragments.—*William Arthur Clark, Pasadena, Calif.*

Treatment of Fracture of the Clavicle by Continuous Traction. Burian. *La Presse Médicale*, January 7, 1922.

A figure-of-eight bandage is put around the shoulders, crossing in the back and pulling the shoulders backward. The continuous traction is obtained by means of a strong rubber tube passing around this bandage in the middle of the back and anchored to the back part of a belt around the waist. To keep the belt down, perineal straps are added. It will be noted that there is no splint applied behind the shoulders.

In applying the apparatus two assistants are necessary. One stands in front, abducts the patient's arms and pushes them backward. The other stands behind, furnishing support with one hand on the patient's back, the patient being seated. There are no dressings over the fractured clavicle and the position of the fragments can be verified at any time.—*William Arthur Clark, Pasadena, Calif.*

A Bone Plate for Use in Fractures Close to Joints or to Epiphyses. W. H. Byford. *Jour. A.M.A.*, Feb. 11, 1922.

A short bone plate of non-corrosive material is described, 1 inch long, ¼ inch broad, and 1/32 inch thick. At each end are three fixed pins ⅜ inch long, with cutting ends. When the fracture has been exposed the plate is to be hammered on. Little force and but a small incision are necessary. The surrounding bones receive little trauma as no drill holes are needed, and the plate may be used on small bones.

A case is cited where fracture of both radius and ulna close to the wrist joint was successfully treated by the plate.—*J. A. Nutter, Montreal.*

Bilateral Subacromial Luxation of the Humerus by Muscular Action in Epilepsy. Costantini. *La Presse Médicale*, January 18, 1922, p. 48.

Malgaigne gave the name subacromial to "a luxation in which the humeral head is found under the posterior angle of the acromion." It is a rather rare lesion; only 34 cases being collected by Malgaigne.

The author reports a case as follows:

A man of 48, after an epileptic convulsion, noticed great difficulty in moving his shoulders. Examination showed no flattening of the shoulder. On the contrary, the upper end of each arm seemed to be somewhat displaced from the body. The elbows were forward and the upper arm rotated inward. The patient could get a spoon up to his mouth only by bending the head down, and with great difficulty and pain. Passive motion in the shoulder limited to slight abduction, internal rotation, and backward motion (hyperextension); all these movements very painful. It was impossible to bring the arm forward (flexion), to adduct it, or to rotate it outward. Roentgenograms showed posterior displacement of the humeral heads and abduction.

The luxations were reduced under general anesthetic by downward traction and rotation both ways until the head snapped back into place. After about a week, motion in the shoulders was normal.

Many of these cases occur during epileptic attacks, 8 of the 34 collected by Malgaigne.

The deformity at the shoulder following such a luxation is very slight. There is no flattening such as is seen in forward dislocations, except a very slight amount anterior which is difficult to recognize except by comparison, which, of course, is impossible in bilateral lesions.

The functional disturbance, on the contrary, is quite marked. External rotation is the most difficult movement because the mechanism which produces the luxation is a strong spasm of the internal rotators of the humerus, pectoralis major, subscapularis, and anterior part of deltoid. This may explain the frequency of bilateral occurrence in epilepsy, the strong muscle spasm acting with the same force on both sides at once. Non-epileptic cases of luxation of

the humerus by muscular force are rarely bilateral; only one in 23 cases collected by de Hintz.

Malgaigne in experiments on the cadaver was able to produce a subacromial luxation by forced inward rotation. The author, in repeating these experiments, found that it was necessary to add a forward projection of the elbow (flexion of shoulder) to the inward rotation in order to produce this luxation. This flexion of the shoulder brings the groove of the anatomic neck of the humerus parallel with the posterior lip of the glenoid so that the head slips off and the groove locks over the lip. If the arm is along the side of the trunk (complete extension), the groove lies at an angle with the lip and consequently does not lock over it. In dissecting the shoulder joint after forced internal rotation with the arm along the side, the author has found the capsule torn posteriorly but the head in normal position.—*William Arthur Clark, Pasadena, Calif.*

MECHANISM OF FRACTURES. FRACTURES FROM SHEARING FORCES. C. Ghillini. *Chir. Org. Mov.*, Vol. 6, No. 1.

From the viewpoint of the mechanism, fractures are commonly divided into direct and indirect fractures from causes of compression, bending, torsion, or avulsion.

When the forces act parallel to the axis of the bone in divergent direction, the resulting fracture is a tension fracture, while with two forces acting parallel with the axis and convergent, the resulting fracture is a compression fracture.

With the acting forces perpendicular to the axis, the fracture occurs in flexion.

With the acting forces perpendicular to the axis and in a circular direction upon a given point, torsion fractures occur. Finally, with the acting forces perpendicular to the axis passing in their plane through the bone, the so-called shearing-force fractures occur.

One of the most common fractures of this kind is that of the lower epiphysis of the radius. Another of this kind is a fracture of the lower end of the humerus. The author cites an example of each of these two kinds, giving radiographs of the fractures.

He presents the x-rays of the two above-named fractures, together with the dynamic explanation of their occurrence, mainly for the purpose of showing that these fractures are shearing fractures and not, as commonly considered, avulsion fractures.—*A. Steindler, Iowa City, Ia.*

FRACTURE AND DISLOCATION OF CERVICAL VERTEBRAE WITHOUT PARALYSIS. W. E. Hartshorn. *Boston Med. and Surg. Jour.*, Feb. 2, 1922.

Report of a case of fracture and forward dislocation of second and third cervical vertebrae with no paralysis at any time, though the displacement was considerable. No effort was made to reduce it. The patient was treated by rest in bed with moderate head traction, followed by back brace with head support. Recovery with only marked stiffness of the neck.—*R. W. Billington, Nashville.*

MANAGEMENT OF FRACTURES NEAR JOINTS. P. H. Kreuscher. *Ill. Med. Jour.*, Feb., 1922.

Dr. Kreuscher recommends the use of the fluoroscope in reducing fractures, and suggests a special apparatus for traction in conjunction with the x-ray outfit. The increased difficulty of caring for fractures near joints is due, first, to the trouble one experiences in approximating the fractured ends; second, to the inability to retain them in place once they have been approximated, and, third, to the complication following bleeding into the joint. Additional factors in severe cases are open fractures with infection. In infected joints he advocates aspiration of the infectious contents and the injection of 2% formalin in glycerin—the Murphy formula—with the addition of 2% apothesine to control pain. In children epiphyseal injuries may lead to later deformities. He gives special consideration to fractures in or near the elbow, hip, knee, ankle, and the temporomaxillary articulation. In fracture of the mandible near the joint he favors the use of the Murphy wedge placed between the maxillae on either side, giving to the jaw the same effect as Buck's extension on the limb in keeping the joint from ankylosing.

Regarding the shoulder joint he believes 95% of the fractures in this position should be reduced by operation, rather a startling statement in the face of so many excellent results obtained by reduction and retention in the right angle abduction position. He prefers deferring operation until ten days have passed to reduce the hemorrhage and the likelihood of infection. The Murphy-Lane operative technic is used, and the Lane plate or wire staples are the mechanical devices used to retain apposition, frequently without the customary external fixing measures, merely placing the arm in a sling with the elbow elevated and the hand flat against the chest in supination.

In elbow fractures, usually involving the internal condyle, if replacement cannot be secured with the aid of the fluoroscope, it should be obtained by operation and held in place with a screw, nail, or peg.

He warns against too early manipulation of the joint as an exciting cause of increased callus formation with consequent limitation of movement. He believes Colles' fracture is usually well managed, a very optimistic view, to say the least. In fracture of the neck of the femur, he states that "a number of surgeons have reported good results from the use of the extreme abduction methods of Whitman." Kreuscher uses the Murphy method, in which the patient, except where there is an impaction, "is placed into a Travois abduction splint with a Buck's extension on the affected limb of from 10-15 pounds."

Further he states, "In a large percentage of the cases, the interposition of joint capsule takes place and prevents a bony union. Inasmuch as this is such an important weight-bearing joint and with our present day methods of bone operations, we are justified in all instances in which the patient's physical condition warrants in doing an open operation through an incision, which gives you direct access to the neck of the femur." A long screw or nail driven through the great trochanter is used for fixation.

In Pott's fracture of the ankle, where reduction is easy, he advises holding the foot in marked inversion from two and a half to three weeks, when the result will be a good one. In the older cases operation is necessary, with retention of the corrected malleolus with a nail or other fixing apparatus.—*Charles A. Parker, Chicago.*

SACRO ILIAC SPRAIN. E. D. Martin. *Southern Med. Journal*, Feb., 1922.

The author read this paper before the Southern Association of Railway Surgeons. Nothing new is brought out; simply a plea to bear the diagnosis in mind in treating pain in the back and legs. Three cases reported.—*Edward S. Hatch, New Orleans.*

DISLOCATIONS AND FRACTURE-DISLOCATIONS OCCURRING AT THE ACROMIO-CLAVICULAR ARTICULATION. R. W. McNealy. *Ill. Med. Jour.*, March, 1922.

In the complete intractable dislocation of this joint McNealy favors an open operation, beveling the clavicle in the opposite direction from the normal shape and tightly approximating the acromion with two piano wire sutures. Fixation is maintained by a Velpeau bandage covered with a plaster bandage for a period of six weeks, when, if conditions are favorable, the wires are removed under local anaesthesia, and light exercises instituted.—*Charles A. Parker, Chicago.*

A MECHANICAL DEVICE TO FACILITATE THE HANDLING OF PATIENTS IN THE WHITMAN ABDUCTION SPLINTS. O. F. Schussler. *Minnesota Medicine*, Feb., 1922.

The author describes a block and tackle method for handling patients who are being treated for fractures of the hip by the Whitman method. A canvas strip six inches wide and sixty inches long, having an iron ring at either end, is placed under the patient at the level of the iliac crests.

Photographs show how the patient may then be lifted and turned by the aid of a double set of blocks suspended from an overhead frame. Such a method helps in the care of the patient, in changing of bedding, and in the securing of rest, which a change in position brings.—*H. T. Jones, Rochester, Minn.*

TWO UNUSUAL CASES OF INJURY TO THE TIBIAL TUBERCLE. James Warren Sever. *Boston Med. and Surg. Jour.*, March 9, 1922.

Osgood and Schlatter, in separate articles, in 1903 called attention to injuries of the tibial tubercle and its epiphyseal cartilage. This condition is still fre-

quently overlooked or confused with other troubles, such as house-maid's knee, pretibial bursitis, etc. The x-ray findings often prove misleading and should always be compared with those of the healthy limb. Operation on the tubercle for fixation of its epiphyseal beak to crest of tibia is rarely necessary and he thinks bone-grafting and pegging for this condition are meddlesome.

The first case reported was that of a boy, age 16, with complete separation of the tubercle due to muscular action while jumping. Open reduction and suture with kangaroo tendon gave a perfect result in three months.

The second case was that of a man, age 22, with chronic disability since an injury to the knee at seven years of age. X-rays showed separation of part of epiphysis, apparently adherent to under side of patellar tendon. There was crepitus at this point on knee motion. This fragment was removed by operation, with complete recovery.—*R. W. Billington, Nashville.*

Treatment of Fractures of the Metacarpals and Phalanges of the Fingers. R. D. Wheeler. *Jour. A.M.A.*, Feb. 11, 1922.

A method of obtaining extension in the case of metacarpal and phalangeal fractures is described and illustrated. A plaster-of-Paris cast is applied to the forearm, incorporated in which is a wire loop projecting two or three inches beyond the fingers. Loops of gauze bandage are attached to the finger ends by a glue composed of celluloid dissolved in acetone, and these loops are attached by rubber tubing to the wire. In this way the overriding and angulation so often seen in metacarpal fractures and those of the proximal phalanges are overcome. Free access to wounds is permitted, and the celluloid is impervious to water.—*J. A. Nutter, Montreal.*

ARTHRITIS.

Arthritis Deformans as a Deficiency Disease. G. C. Belcher. *British Medical Journal*, February 4, 1922, p. 186.

While multiple arthritis frequently associated with some deformity in children can, like acute rheumatism, usually be said to be related to blood infection, the chronic arthritis occurring chiefly in adult or middle aged women, less often in young adolescents and men in middle life, does not to the mind of the author come under the category of an infection. Comparing these cases with diseases connected with improper feeding impressed the writer that these conditions were associated with deficiency diseases. Arthritis deformans is frequent in women of the poorer classes who rarely have properly selected food; then these women are deprived of the essential salts necessary to health existence, and the mineral salts contained in the bone are taken up into the poorly nourished blood and tissues with low mineral content, leaving the bone in the eroded condition so well known in the last stages of the disease. One of the chief reasons for the association of the arthritis with deficiency disease is that its occurrence is most often in the class of patients who have been for years living upon an improperly selected diet.

The author notes also that in one district where the water was hard, with a large amount of both temporary and permanent salts, that the occurrence of osteo-arthritis was infrequent. In another district, where the water was soft with little or no temporary or permanent hardness, cases of osteo-arthritis were much more numerous.—*L. C. Abbott, Ann Arbor, Mich.*

THE TREATMENT OF CHRONIC ARTHRITIS, WITH SPECIAL REFERENCE TO END RESULTS. Walter L. Bierring. *Illinois Medical Journal*, June, 1921.

All cases of arthritis should be regarded as chronic where the symptoms have extended beyond one year.

The treatment consists of: 1, removal of infective foci; 2, local therapy to the affected parts; and 3, general care of the patient.

Practically all cases of chronic arthritis are due to some infective agent. The most frequent sites of focal infection are the teeth, tonsils, genito-urinary tract, sinuses, bronchi, gall-bladder, gastro-intestinal tract, pancreas and the appendix.

The question of what constitutes pathology in the tonsils is a matter on which there is room for considerable discussion. Dental foci, although clearly demonstrable by the radiologist, are open to false interpretation. For clinical purposes arthritis may be classed with diabetes and gout, in that there is in each case a limit of tolerance for carbohydrates on the one hand and proteids on the other. Special dietary regulations as a means of therapy in selected cases of chronic arthritis are advisable, especially where a demonstrable focus of infection or definite causative agent is not present.

There is no measure that affords so much relief and comfort as baking the affected joints, usually carried out daily with one free day each week. It relieves pain and has a good effect on the swelling and stiffness. When the acute symptoms have subsided systematic massage should be given by an experienced masseur. Medicines occupy but a minor place. Vaccines and the injection of foreign protein are still in an experimental stage.

While the removal of the infective foci should be of first importance, the general care of the patient should have an equal place in any plan of treatment, and this can only be properly carried out in a hospital where every facility for examination is available and all possible forms of therapy may be used.

The problems involved in diagnosis and treatment bring these cases properly within the sphere of internal medicine, the advice and co-operation of the orthopedic surgeon being a necessary factor in the successful treatment.—*Walter G. Elmer, Philadelphia.*

CHRONIC ARTHRITIS. Leonard W. Ely. *Medical Record*, February 11, 1922.

Ely divides all chronic arthritides into two classes which he designates simply as Type I and Type II. This division he makes on the basis of the pathological anatomy and roentgen appearances of the bones. Moreover, it happens that all those cases which belong in Type I have a known etiology, while the cause of Type II is unknown. Beside this, the clinical behavior of the two groups is quite different.

Type I includes the condition known by various writers as proliferative arthritis, atrophic arthritis, rheumatoid arthritis, etc. The causative agent is

one of the known infections—tuberculosis, syphilis, typhoid, pneumococcus, diplostreptococcus, etc. The lesion is a proliferative inflammation in the synovial membrane, bone marrow or both, resulting in recovery or in fibrous or bony ankylosis. The x-ray shows rarefaction of the bone, thinning of the cartilage, but no new production of bone. Clinically Group I causes pain, local sensitiveness, and limitation of motion, and usually local temperature, swelling of soft parts, muscle spasm, and atrophy, but no new production of bone outside the normal level. The joint may or may not contain fluid. This form may be mono- or multi-articular. The x-ray shows a rarefaction of bone next the joint, irregularity of joint outline and approximation of the bones forming the joint because of thinning or destruction of the cartilage. Treatment of this group includes the removal of the cause in tubercular cases, depriving the joint of its function either temporarily or permanently.

Type II is a multiple, progressive form of arthritis whose cause is unknown. All attempts at demonstrating a bacterial origin of this type have been unsuccessful, yet the appearance of specimens indicates an infection of some sort as the cause. The author inclines to the belief that the offending organism is a protozoon, probably the amoeba histolytica, gaining access to the circulation most frequently through diseased alveolar processes at the roots of decayed teeth. The primary lesion in this type is a necrosis in the bone marrow in the immediate vicinity of the joint, whose cause is unknown. New bone is then laid down about the necrotic areas, especially beneath and at the periphery of the joint cartilage. The cartilage becomes calcified and wears away, leaving eburnated bone, while lipping occurs around the edges of the joint distorting the ends of the bone. The synovial membrane becomes thickened and villous, causing creaking and grating on motion. The subjective symptoms are less marked than in Type I, but in the spine this type may cause interlocking or even bony union.

The differential diagnosis between the two types is best made by the x-ray examination, which shows new bone formation in Type II.

The principal indication in the treatment of Type II is the removal of foci of infection from about the roots of teeth. The new bone formation is permanent.—*C. L. Lowman, Los Angeles.*

THE AMOEBA AS THE CAUSE OF THE SECOND GREAT TYPE OF CHRONIC ARTHRITIS. PRELIMINARY NOTE. By Leonard W. Ely, Alfred C. Reed and Harry A. Wyckoff. *California State Journal of Medicine*, February, 1922.

The "Second Great Type" is the name applied by the authors to the condition known as arthritis deformans, osteo-arthritis, hypertrophic arthritis, etc.

Ely has previously shown that the primary change is a necrosis in the bone marrow in the neighborhood of the joint, of hitherto unknown cause. Dr. John V. Barrow of Los Angeles suggested a relationship between amoebae and this necrosis, after having found the amoeba histolytica in the stools of one of Ely's patients. Following this suggestion endamoeba histolytica were found by the authors in sections of bone from the region of the necrotic areas. These were abundant in the region of the necrotic area but not actually in the necrotic areas.—*C. L. Lowman, Los Angeles.*

INFECTIOUS ARTHRITIS OF THE SPINE. Sigmund Epstein. *Amer. Jour. Med. Sciences*, March, 1922.

Arthritis of the lumbar spine, traceable to infections, is a common cause of low back pain. Staphylococci, streptococci, Eberth's paratyphoid bacilli, are the usual causative organisms. (Gonorrheal, syphilitic, and tabetic spines not included.)

Inflammatory exudate, adhesions, absorption of cartilages, destruction of bony tissue, deposits, excrescences, and ankylosis take place. Deviation of the spine and moderate kyphosis may occur. Acute cases are often mistaken for Pott's disease or sciatic scoliosis. Under treatment the deformity may be overcome and recovery take place with but little impairment of function. Treatment is essentially mechanical: plaster jacket and rest in bed during the acute stage, braces to control deformity and prevent relapses, removal of definite foci of infection. Six interesting cases are reported with three illustrations.—*F. G. Hodgson, Atlanta, Ga.*

RHEUMATOID ARTHRITIS DUE TO INFECTION OF THE NASAL ACCESSORY SINUSES. By P. Watson-Williams. *British Medical Journal*, January 21, 1922, p. 88.

The author believes that while the teeth, tonsils, genito-urinary and gastro-intestinal tracts have received due attention, there lies in the nasal accessory sinuses a possible source of infection which merits more attention than hitherto has been accorded to this region. Several cases have been sighted in which drainage and treatment of the accessory sinuses has resulted in relief from symptoms with great improvement in cases of arthritis.

The author states in examination of sinuses it will often be found that the patient with very badly infected sinuses with pus streaming from one or both nostrils may be in apparently good health, while another patient who has nothing but a slight nonpurulent discharge is depressed, thin and sallow and obviously in poor health. The author believes that in the pronounced infections there is a profuse outpouring of polymorphonuclear cells which wall off the infection and prevent absorption; in slight infections with few pus cells toxic absorption is more pronounced. He makes a plea for a more thorough examination of the nasal accessory sinuses in cases of systemic infection.—*L. C. Abbott, Ann Arbor, Michigan.*

TREATMENT OF GONORRHEAL ARTHRITIS BY INJECTION OF THE JOINT FLUID. MM. H. Dufour, J. Thiers, and Mme. Alexewsky. *Bull. de la Soc. Méd. des Hôpitaux*, Nov. 25, 1921.

The method of treatment consists in aspirating the fluid from the affected joint and immediately reinjecting a small amount of it subcutaneously. The dose is 10-20 c.c., and the procedure is repeated once a week as long as fluid can be obtained from the joint. In a previous article they have reported four other cases and they now report two more. Other observers have also reported results, making now a total of thirteen cases. Rapid improvement followed in all cases. One of the cases here reported was in the suppurative stage. The

joint fluid was full of leucocytes with typical intra-cellular diplococci. No local reaction has occurred in any of their cases.—*P. D. Wilson, Boston.*

CONGENITAL ABNORMALITIES.

CERVICAL RIB, WITH REPORT OF TWO CASES. Paul C. Colonna. *Am. Jour. Med. Sciences*, January, 1922.

Sixty per cent. to 70 per cent. of reported cases occur in females. It is usually bilateral, with one side much larger than the other. Although the condition is bilateral, the symptoms rarely develop before the second decade. Symptoms produced are not definitely related to the size of the anomaly.

The usual signs and symptoms are:

1. Hump-like prominence in the lateral cervical region.
2. The appearance of pressure symptoms manifested by circulatory or nervous disturbances.
3. Superficial pulsation of the subclavian artery.
4. Cervical scoliosis.

Pressure symptoms may be referable to pressure on the brachial plexus, the cervical sympathetic, the pneumogastric nerve, or the subclavian artery.

The differential diagnosis.

The conservative treatment consists of rest in bed for a few weeks with elevation of the arm, and sometimes heat, massage, electricity, etc., but most authors agree that this is a waste of time. The surgical treatment is a difficult major operation. The periosteum should be removed with the rib to prevent recurrence. The anterior approach is made by cutting the platisma, double ligation and division of the external jugular vein, exposing the great vessels and the brachial plexus, and cautiously retracting them over the cervical rib, especial care being taken to avoid the pleura. The soft parts are separated, and as much of the rib as possible is resected. The posterior approach is by a longitudinal incision, 2 cm. lateral to the spinous processes. The muscles are cut through or separated, and a curved elevator passed around the neck of the rib, and the latter is divided. The soft parts are separated from the rib, and as much as possible resected. There is danger to the nerve, especially to the serratus as it passes through the scalenus medius.

The cases reported were, in brief:

Case 1: Female, aged 24 years, with numbness of the whole right arm. The rib was exposed by the anterior incision and 1¾ inches resected. She was completely relieved.

Case 2: Female, 21 years, complained of blue and cold fingers of the right hand. About 2½ inches of the rib were resected by piecemeal with bone forceps. Recovery uneventful.—*F. G. Hodgson, Atlanta, Ga.*

CONGENITAL DEFORMITIES AND ANOMALIES OF THE HYPOPHYSIS IN A TWIN. Nino Samaja. *Chir. degli Organi di Movimento*, Vol. 5, No. 6, December, 1921.

The paper is based upon observations of deformities made in one of the twins observed, a boy of 16.

These deformities concerned mainly the lower extremities. The right lower extremity was generally somewhat stunted in growth in comparison with the trunk and there was a dislocation of the hip. The left lower extremity was greatly deformed through maldevelopment of the extremity in all its sections so that it presented a rather small and atrophic stump which could not be used for erect posture and for gait.

The dislocation on the right side was reduced operatively; the left limb was furnished with a splint sufficient to allow walking. An examination of the hypophysis in the x-ray picture revealed the following facts:

1. The presence of a sella turcica of reduced dimension.
2. The reduction of the dimension of the sella turcica concerned both twins, although one showed a body development which was rather in excess of normal while the other had the deformities which have been mentioned.

From the study of these two cases the author finds a connection between the diminution in size of the hypophysis and the general bodily development. He points out that the finding could not be construed as a coincidence but that there is a rather definite connection between the development of the hypophysis and the occurrence of deformities or irregularities in growth in general. He admits, however, that further researches will be necessary in substantiation of his theory.—*A. Steindler, Iowa City, Ia.*

Cervical Ribs: With Special Reference to the Surgical Treatment. Alfred S. Taylor. *N. Y. State Jour. of Med.*, March, 1922.

The first section of this comprehensive and important paper recapitulates the outstanding features of the morphology, incidence, and anatomy of cervical ribs. These ribs appear in females as compared to males in the ratio of three to one. They are usually bilateral and with rare exceptions are attached to the seventh cervical vertebra. They vary in size from a somewhat enlarged transverse process to a complete rib which articulates with the vertebra and the sternum. The size of the rib is not to be taken as an index of the severity of compression symptoms which may be set up. Indeed, the smaller and less normally formed ribs are often responsible for the greatest degrees of compression. In the more rudimentary ribs, too, there is usually found arising from the tip of the false rib an aponeurotic band running forwards and downwards to an attachment to the first true rib. Such a band causes the same symptoms as does a complete false rib. In the presence of these accessory ribs, the subclavian artery rises to a higher level, and in those cases in which the false rib is joined to an upward bony projection from the upper surface of the first true rib, the artery crosses the latter just in front of the bony projection. The subclavian vein is changed in position only when the false rib is complete and reaches the sternum. The eighth cervical and first dorsal nerve roots pass up over the false rib to join the plexus and show the results of pressure in motor, sensory, and vasomotor disturbances in their peripheral area of distribution. The author points out that the symptoms first appear at about the age of thirty and often after some debilitating illness, or operation, for some other condition. No mention is made of the relationship of the pre- and post-fixed types of plexus.

In discussing the symptomatology, it is pointed out that sensory disturbances are the first to appear, and being mild and indefinite, at first they are apt to be attributed to neuralgia, rheumatism, and the like. The pain and paraesthesia affect the ulnar side of the hand and forearm, and anaesthesia may finally supervene. A number of writers have published cases in which dissociated sensory disturbances suggested syringomyelia, and Bassoe has emphasized the fact that true syringomyelia is a not infrequent associate of cervical ribs. The signs of motor disturbance also develop insidiously and lead to atrophy and loss of power in the small muscles of the hand; claw-hand deformity may ultimately result, and the importance of operating before this terminal stage develops is stressed by the writer. Trophic vasomotor disturbances are met with in the ring and little fingers. After symptoms have made their appearance, the probabilities are all in favor of their progression, either steadily or with intermissions.

The procedures for operative removal of cervical rib have been classified into three general groups: 1. The "anterior," in which an incision is made along the posterior border of the sternomastoid muscle. It is condemned because it involves too much manipulation of the plexus. 2. The "lateral," in which an incision is made above and parallel to the clavicle or runs along the anterior border of the trapezius. 3. The "posterior," in which a vertical incision is made 2 cm. to the side of and parallel to the spinous processes of the cervico-dorsal vertebrae, giving an approach through the trapezius muscle.

The author advocates the antero-lateral mode of approach, by an incision starting at the posterior edge of the insertion of the sterno-mastoid muscle and passing upward and outward to the border of the trapezius muscle, making an angle of 45 degrees with the clavicle. The cervical fascia is divided along the outer border of the plexus, which is then separated from its bed posteriorly sufficiently to expose the rib and permit gentle retraction forward of the plexus. When the accessory rib is rudimentary and buried in the scalenus medius muscle, its location is found by feeling for the carotid tubercle as the guide. The muscular and ligamentous structures attached to the rib are divided by sharp dissection so as to leave all periosteum on the rib, and great care must be taken to preserve the pleura. The last portions to be freed are the head and neck of the rib, and the intimate relationships of the seventh cervical root and of the vertebral artery are discussed. Good illumination is necessary. After the outer portion of the rib has been freed it is grasped by forceps and a clean enucleation of head and neck attempted. If the peculiar conformation of the rudimentary rib makes the last part of the operation difficult, it may be advisable to leave the head of the rib *in situ* and divide it by small rongeurs as close up to the head as possible; the strong aponeurotic extension must be divided. The wound is closed without drainage. The operation combines the following advantages: a. It is sufficiently free to permit of complete removal and to allow control of bleeding. If the vertebral artery is injured it must be ligated at its origin. b. It permits of a minimum of manipulation of the plexus. c. The scar is inconspicuous. d. The whole dissection follows natural lines of anatomical cleavage.

The article is completed by a fully reported series of five cases and is illus-

trated by excellent photographs of the clinical features, x-rays, and specimens of removed ribs.—*W. A. Cochrane, Boston.*

OPERATIVE PROCEDURES.

ARTHROPLASTY OF THE ELBOW JOINT: A POINT OF VIEW. Harold C. Bean. *Boston Med. and Surg. Jour.*, March 9, 1922.

Reports of operators are rather misleading as to advisability of this procedure in the hands of the average surgeon, the author believes. Because of the importance of the prerequisites, the length of time necessary for end-results, the lack of definite predictions as to outcome, except in a very limited number of cases, he has yet to see the advantages of a few degrees of stable motion over an ankylosis in favorable flexion or an excision with a moderately flail joint. He thinks careful selection of cases and an exact technic by an experienced operator in such cases are essential to a good prospect of success. He favors the MacAusland operation.—*R. W. Billington, Nashville.*

STIFF FINGERS. F. J. Cotton and E. J. Sawyer. *Boston Med. and Surg. Jour.*, Feb. 9, 1922.

For stiff finger-joints the authors employ continuous traction combined with a gradual flexing or extending force to overcome the soft tissue resistance. Special splints and their application are illustrated. Eight cases are reported. No credit is given for the extensive use of this principle and some very similar splints by both British and American orthopaedic surgeons during the war, where it was found that this method gave best results when combined with and followed by physiotherapy. The authors rather discredit the value of physiotherapy in these cases.—*R. W. Billington, Nashville.*

METHODIC MOBILIZATION IN THE TREATMENT OF ARTICULAR AFFECTIONS. Kouindjy. *La Presse Médicale,* January 11, 1922, p. 42.

The recent revival of the mobilization method in treatment of joint lesions only confirms the principles established in 1841 by Teissier of Lyon. He proclaimed that prolonged immobilization is dangerous, not only for pathologic joints but for normal joints.

A perfectly sound joint held in absolute immobility may become stiff or even ankylosed by changes in the synovial membrane and cartilages. Teissier examined many joints at autopsy of patients who had died after prolonged fixation of a limb for fracture. He found almost constantly that the normal synovial fluid was replaced by a sero-sanguinous material. This extravasation was found not only in the joint cavity, but in the extra-articular soft parts. The folds of the synovial membrane were swollen and reddened as though by a passive hyperemia and adherent more or less to the cartilaginous surface. All this may occur in case of lesions for which immobilization has been maintained for two or three months, *i.e.*, the time required for healing a fractured femur. But when, because of delayed union, this form of treatment is kept up for six

or eight months, or even longer, there may occur in previously healthy joints a condition a hundred-fold worse than the original fracture.

The author has quoted quite extensively from Teissier as above in order to emphasize the teachings which this clinician put forth about eighty years ago.

To illustrate the development of ankylosis a case is reported of a patient 20 years of age who had an attack of multiple arthritis resulting in a painful right knee. After two months in the cast, a roentgenogram of this knee showed normal joint surfaces, but after five months another picture revealed a loss of normal contour of these surfaces and a marked narrowing of the space separating them. Owing to lack of the patient's coöperation, the leg could not be mobilized and the knee continued to grow more and more stiff until a roentgenogram taken a year after the lesion appeared showed a complete bony ankylosis. —*William Arthur Clark, Pasadena, Calif.*

Leveling (Balancing) the Pelvis in Cases of Inequality of Length of Legs, with a Description of a Pathognomonic Sign. Philip Lewin, M.D. *Jour. A.M.A.*, March 18, 1922, page 804.

This case report concerns a girl of 17 with infantile paralysis which had resulted in two inches of shortening of one leg. From this shortening resulted a marked scoliosis towards the affected side, which scoliosis was made to disappear by raising the short leg and so balancing the pelvis. The importance of such pelvic balancing or leveling is emphasized in all cases of scoliosis accompanied by a short leg. Attention is drawn to the importance of difference in level of the posterior superior spines in cases of short leg, as also of difference of level of the gluteal creases. When such phenomena occur the pelvis may be assumed to be depressed on one or other side, a condition necessarily to be corrected in the treatment of an accompanying scoliosis.—*J. A. Nutter, Montreal.*

Amputations at the Shoulder and at the Hip. H. Littlewood. *British Medical Journal*, March 11, 1922, page 381.

The author notes that he described his operation for removal of the upper extremity ten years ago, but in this article describes it in fuller detail. His operation differs from that described by Prof. Berger in that the approach to the vessels is made from behind and in Berger's operation preliminary ligation of the vessels is done. Littlewood believes that his operation is preferable because it gives easy access to the vessels and the operation can be done in a shorter time.

Description of the Operation.

Two flaps are formed, a cervico-scapular and a pectoro-axillary. The patient is placed on the sound side close to the edge of the operating table. A cervico-scapular flap is made, commencing at the clavicle near the outer margin of the sterno-mastoid attachment, carried along the clavicle over the prominence of the shoulder along the axillary border of the scapula to a point below the angle and backwards to about two inches from the spine. A flap of skin and subcutaneous tissue is rapidly turned back; this exposes the posterior surface of the scapula with muscle attachments. The trapezius and latissimus dorsi are

divided, next the levator anguli scapulae, the rhomboids, and lastly the scapular attachments of the serratus magnus and omo hyoid. Three or four vessels may require ligature, branches of the supra-scapular and posterior scapular arteries. The soft tissues are now separated from the clavicle close to the sterno-mastoid attachment, and the bone divided by Gigli saw. The whole extremity now falls away from the trunk, held by the subclavian vessels and the cords of the brachial plexus, which are fully on the stretch, standing out and easily seen. The cords of the plexus are now divided, clips applied to the subclavian artery and vein. The anterior pectoro-axillary flap is reflected as far as it is found necessary. The last stage of the operation consists of the division of the pectoralis major and minor. The forequarter is then removed and this exposes the thoracic boundaries of the axilla and the posterior triangle of the neck so that lymphatic glands can be removed.

Amputation Near the Hip-Joint. (Supratrochanteric.)

The author first performed the operation in 1897. The object is to leave the hip-joint intact and there is less shock than in the operation for disarticulation.

Description of the Operation.

An anterior internal flap is formed beginning just below the anterior superior spine of the ilium, coming down to a level to provide for an adequate covering of the stump—that is, one-third of the thigh's circumference, then over the front of the thigh and upward to the inner and posterior aspect near the tuberosity. The posterior external flap is now made. The anterior internal flap is now dissected upwards and the femoral vessels are ligated. This is followed by division of the muscles and ligation of the branches of the profunda. The muscles of the posterior external flap are then divided. The flaps are then held aside and the anterior portion of the capsule attached to the trochanteric line is reflected upward for a distance of one-half inch. The neck of the femur is then divided close to the trochanter and the extremity removed.

In excisions Littlewood does not use the tourniquet because he has found that there is less oozing post-operatively. This principle he has applied to amputations.—*L. C. Abbott, Ann Arbor, Michigan.*

THE TREATMENT OF ARTHROGENETIC CONTRACTURES OF THE KNEE WITH PARTIAL ALCOHOLIZATION OF THE SCIATIC NERVE. Dario Maragliano. *Chir. degli Organi di Movimento.* Vol. 5, No. 6, December, 1921.

It is well known that inflammatory conditions of the knee cause very early flexion contractures of this joint. This contracture in the early stages of the inflammation is due to reflex action caused by the irritation of the sensory nerve endings in the synovial lining and in the capsule.

Jansen has advanced the theory that in the knee as well as in other articulations the contracture due to reflex spasm is maintained mainly by the polyarticular muscles, and, in much lesser degree only, by the monarticular muscles. In the knee-joint the extensors are almost entirely monarticular, while the flexors of the knee are all polyarticular muscles, and from this point of view the early tendency to contracture of this joint may be explained.

Other conditions contributory to contracture may be the atrophy of the extensors, the structural shortening of the flexors, the distention of the capsule and the organization of the exudate. In this publication the author deals exclusively with such flexion contractures as occur in the wake of an inflammatory process in the knee and in which there is a certain residual motion. The ordinary curative methods of correction of deformity are the forcible redressment, tenotomies and tendon lengthening and the supracondyloid osteotomy. It appears to him a logical procedure to influence directly the innervation of the flexor muscles in such a manner that the centripetal stimulus is eliminated or weakened.

At the lower border of the gluteus maximus the muscle fibers supplying the long head of the biceps, the semi-tendinosus, and semi-membranosus are found all together in a common bundle, so that it is easy to isolate these nerves from the trunk of the sciatic nerve. By interruption of the conductivity of the nerve fibers of this bundle, two results are obtained: 1. That of elimination of the centripetal stimuli, and 2, the diminution of the motor reaction.

It appeared to the author that a complete or anatomical interruption was not a desirable object. Rather than that, the interruption should be only a physiological one. This may be obtained in three ways: by ligature of the nerve with catgut; by freezing methods according to Trendelenburg; and, finally, by alcoholization with 60 per cent. alcohol.

The idea of alcoholizing nerves in order to eliminate contracture is not new. Among others, Sicard and Imbert applied this method in muscle contractures subsequent to war wounds.

The clinical results obtained by the author in three cases demonstrate that the diminution of the flexor action of the semi-tendinosus, semi-membranosus, and biceps, by alcoholization of the nerve trunk, eliminates the most obstinate flexion contractures which follow inflammatory conditions in the knee.

In two cases the alcoholization gave a very good result, such as even a very prolonged redressment procedure would not have obtained. In the third case there was an almost right angular flexion contracture due to tuberculous synovitis. The alcoholization obtained correction after only one month of redressment, which correction maintained itself during twelve months of observation.

It is important to know that in the experiments different animals react differently to alcoholization: in dogs a complete paralysis, sensory as well as motor, ensues, but the pathological lesions which are found at the point of injections do not involve all the nerve fibers. In all experiments of the author, as well as in those carried out by others, it was constantly found that certain sections or nerve bundles escape the action of the alcohol to a greater or less degree.

Petries and Marchant, who carried out similar experiments in 1917, attach great importance to the use of alcohol of 60 per cent. strength, in which concentration the motor conductivity is interrupted without altering the sensory conductivity. With this opinion the author takes decided issue. The alcoholization of the mixed nerves in men show distinctly that the sensory conductivity as well as the motor conductivity is suspended. It is well known that the first attempts to cure the neuralgia of the sciatic nerve were discouraged by the fact

that motor paralysis developed together with sensory paralysis. There is one point, however, that must be admitted, and that is, that there is a certain difference in the degree of action of these inter-nervous injections of alcohol in different species of animals. The author observed that rabbits are affected to a much higher degree than dogs.

In conclusion the author feels that the alcoholization of the nerve bundles can be justly proposed as an effective means to combat flexion contractures in the knee by eliminating the contracture of the semi-membranosus, semi-tendinosus, and of the long head of the biceps.—*A. Steindler, Iowa City, Ia.*

EXPERIMENTAL LENGTHENING OF THE LIMBS. O. Nuzzi. *Chir. Org. Mov.*, Vol. 6, No. 1, 1922.

The division of bone for the purpose of operative lengthening may be accomplished by oblique osteotomy, by z-shaped osteotomy of Vulpius, by the U-shaped osteotomy of Fassett, but the best method is considered that of Putti, who divides the bone in Z fashion, incising the periosteum in the same manner, only with the short branches of the Z cut in opposite direction. The longitudinal cut through the bone is made by the circular saw, as is also the horizontal cut of the outer half, while the horizontal cut of the inner half is carried out by means of a Gigli saw.

The point of election for the osteotomy is not the place of the deformity itself, but a point at some distance from it, mainly because of the danger of infectious material harbored in the callus, and also because of the insufficient osteogenetic qualities of the callus. The maximum lengthening cannot be obtained in one sitting, but must be attempted gradually. Putti obtains it in from 20 to 30 days.

For the purpose of lengthening the bone, Putti has used since 1917 an instrument which he calls the osteotone. and which he described then in his article on traction by double skeletal transfixion. This osteotone is capable of producing a constant, gradual, and calculable amount of traction or distention of the bones.

It is necessary to know something about the elasticity of the contracted soft tissues, especially the muscles, nerves, and fascia, in order to judge the amount of lengthening obtainable.

The author has carried out extensive experiments on rabbits in order to study the amount of lengthening of these tissues obtained by certain degrees of traction forces. From his experiments, which were carried out under strict dynamometric control, he finds that it is possible to lengthen the normal limb by direct traction upon the skeleton. Regarding the elasticity or the amount of lengthening obtainable by certain force, the different tissues act differently among themselves, and there is also a difference between the living and the dead animal as well as a difference between the lengthening obtainable in one sitting and that obtainable in several sittings. He finds that in living elastic tissue, there is normally a certain unused power of elasticity which can be made use of in operative lengthening of the extremity. The lengthening has to be tolerated if carried out in repeated sittings.

In regard to the vaginal fascia, the author finds that sectioning of the fascia increased the amount of lengthening possible. The force required for a certain amount of lengthening after sectioning the fascia decreases to about one-fourth of the force required with the fascia intact. It therefore seems that the deep aponeurosis of the thigh absorbs about three-fourths of the weight necessary to produce a certain amount of lengthening of the limb.—*A. Steindler, Iowa City, Ia.*

THE POST-OPERATIVE TREATMENT IN CERTAIN SURGICAL PROCEDURES ON THE UPPER EXTREMITY. Arthur Steindler. *Chir. degli Organi di Movimento,* Vol. 5, No. 6, December, 1921.

The conclusions of the author are as follows:

1. Following the operation it is necessary to provide an adequate period of rest and absolute fixation in order to re-establish the tissue equilibrium, and in order to restrict as much as possible the local operative reaction.
2. The relaxation of the muscles involved and the absolute avoidance of fatigue to which weakened muscles are inordinately susceptible is a necessary principle.
3. It is necessary to institute the re-education of muscle power, and this re-education must start from positions of absolute rest.
4. It is necessary to institute systematic development of the muscles of the neighborhood and of such muscles which take care of compensatory motion.
5. It is necessary to interpose a phase of muscle education between the mechanical treatment and the occupational therapy.
6. It is necessary that this intermediate phase be governed by a system of standardization which concerns the objects used, the movements selected and the promptness and velocity of motion to be obtained. For the graphic demonstration of results obtained by this intermediate method of muscle education under standardized rules, graphic curves can be drawn which can be reduced to a percentage basis by comparison of the affected extremity with the sound one.—*A. Steindler, Iowa City, Ia.*

NEOPLASMS.

JOINT MYXOMA. G. Bolognesi. *Chir. Org. Mov.,* Vol. 6, No. 1, 1922.

One case of myxoma of the knee-joint observed by the author is minutely described. In the histological examination, the entire synovial layer was found transformed into a myxomatous tissue. The anatomical diagnosis was a pure and simple myxoma diffusing into the synovial membrane of the knee-joint with a focus of an osseous myxoma in the internal condyle of the femur.

The clinical picture of the patient pointed to an endosynovial lesion which developed after a trauma upon which a hemarthrosis and later a secondary traumatic arthritis followed. The clinical course might have caused suspicion of a tuberculous arthritis, but the findings at operation rather permitted the assumption of a myxomatous tumor developing on the basis of an inflammatory

process subsequent to trauma, and this diagnosis was finally confirmed by the histopathological findings.

The symptoms presented in this case were briefly the following: A more or less diffused swelling of the knee with dilatation of veins of the skin; pain upon exploration was located in the joint line but was neither constant nor very intense. Motion in the joint was at least partially preserved, a symptom which the author thinks is of importance in differentiation from an inflammatory condition of the joint.

Joint tumors might clinically be distinguished in the following groups:

(1) Circumscribed tumors with small nodules; sometimes pedunculated;

(2) Larger tumors always localized in a certain section of the articular capsule, and

(3) Diffused tumors of the synovial membrane.

The circumscribed tumors are more often benign, while the diffused tumors are usually of malignant character. Nevertheless, one may observe lipoma or fibroma of diffused character.

In regard to the differential diagnosis of the articular myxoma, tuberculous fungous arthritis is first to be considered. In this respect, the good general condition of the patient in myxoma is of importance. There is also the absence of signs of scrofulosis or adenopathy and of other tubercular lesions to be noted. The joint pain, especially spontaneous pain, is much less than it is in fungous disease. In spite of the sometimes considerable extent of the tumors in the joint, there is no periarticular infiltration in myxoma, and the movements in the joint are at least partially preserved.

The radiological examination does not give definite information. The picture found in these tumors might apply to chronic osteomyelitis or syphilitic arthritis or rarefying osteitis or tuberculosis.

The surgical interference in these tumors may consist either in local removal of the tumor or in total resection of the synovia, or in joint resection, or, finally, in amputations. In his case, the author carried out the articular resection, which is sufficient when the following examination shows that the tumor is benign.

The pure myxoma consists of an embryonal tissue and is one of the rarest forms of neoplasm. It has been found in certain internal organs, in the subcutaneous tissue of the umbilical region, in the periosteum, in the aponeurotic fascia, in the muscle sheath, in the connective tissue of the mucous membranes, in the connective tissue of the bone marrow, and in the nerves. Mixed forms, such as chondro-myxoma and myxo-sarcoma, etc., are by far more frequent. The case of the author is to be regarded as most exceptional because of the simplicity and purity of the histological picture. The author believes that the primary myxoma of an articular cavity offers symptoms similar but not quite identical to those of fungous arthritis.—*A. Steindler, Iowa City, Ia.*

OSTEOMATA OF THE BRACHIAL TRICEPS. Massart. *La Presse Médicale*, January 25, 1922, page 130.

Most of the studies devoted to osteomata in the region of the elbow do not mention the rather rare occurrence of these growths in the triceps. Only five

cases were found in the literature previous to the two cases reported by the author.

Case 1. A chauffeur, who, when three years old, had broken his olecranon, now shows normal motion and appearance of the elbow except for two bony masses visible and palpable above the olecranon in the triceps tendon. Roentgenogram of the original fracture in 1902, when the patient was a child, shows an incomplete fracture of the olecranon. The present roentgen picture suggests that the osteomata are the result of callus thrown out in repairing the old fracture. The two bony growths are about the size of almonds and are separated by a space of only 2 mm.

Case 2 is a child of 10 who had a comminuted fracture of the right radial head in 1915. At present he shows normal flexion but limited extension and rotation in the elbow. Roentgenogram shows an osteoma on the posterior aspect of the humerus between the condyles; apparently an intra-articular callus.

The origin of these osteomata is a subject for more or less theoretical discussion. In the first case the original roentgenogram gives evidence against the idea of aberrant callus formation. The theory of dislodgment of part of an epiphysis still cartilaginous and developing into bone in its new position is scarcely tenable. The most probable theory is that of periosteal origin, a portion of periosteum being torn off at the time of the fracture and producing the bony growth in the site where it lodged.

In the second case, however, the osteoma seems to have developed from the olecranon, probably as a result of the trauma at the time of the fracture, which caused a disturbance in ossification of the epiphysis.—*William Arthur Clark, Pasadena, Calif.*

SARCOMA OF THE LONG BONES. (A STUDY OF MICROSCOPICALLY PROVEN CASES.) H. W. Meyerding. *Surg., Gyn., and Obstet.*, March, 1922, page 321.

Four hundred and seventy cases of sarcoma of the extremities were seen at the Mayo Clinic from 1907 to 1921. Thirty-five per cent. of these, or 168, were sarcoma of the long bones, and only 65 per cent., or 109, of the sarcomata of the long bones were operated upon. The remainder, 35 per cent., were inoperable or the patient refused operation.

The author's report is based on 109 cases which were operated upon. The article is illustrated with photomicrographs of sections of these tumors and x-rays of the lesions.

The types of sarcoma were classified as mixed-cell sarcoma, round-cell sarcoma, osteo-sarcoma, chondro-sarcoma, and fibro-sarcoma. The most malignant type found was the osteo-sarcoma; the most common type was the mixed-cell sarcoma, and the least common was the fibro-sarcoma. The so-called foreign body giant-cell tumors are not included in this report because they are considered benign tumors.

In discussing the etiology of sarcomata, he mentions local trauma and inflammatory process of bone as possible factors. In his series, 53.2 per cent. of the cases gave a history of trauma. The average age was 26.7 years, and the common age was between 10 and 40 years.

Clinically, the diagnosis of sarcoma of the long bones is not always easy. It must be differentiated from benign neoplasms such as foreign body giant-cell tumors, chondromas and fibrocystic disease, from syphilis and osteomyelitis. The diagnostic value of x-ray is frequently overestimated. It is helpful in determining the exact location of the tumor, the extent of its growth, and gives us the earliest evidence of lung metastasis, which is the most common complication. Routine x-ray examination of the lungs should be made in every case to rule out metastasis.

The treatment is dependent upon the duration, site, and extent of the lesion. Non-surgical cases are treated with Coley's toxins, radium, or x-ray. If the treatment is surgical, the growth is eradicated locally by cautery, by excision, or by amputation, followed by non-surgical measures. He emphasizes the fact that before any radical operations are performed, the tumor should be explored and the diagnosis of sarcoma made by the microscopic appearance of the tumor. This should be a routine procedure in every case of suspected sarcoma. Sixty-six patients had amputations, and 21 of these, or 31.8 per cent., died of metastasis to the lungs. Nineteen patients had excisions and cautery, and 10 of these, or 52.6 per cent., have died. Twenty-four had local operations of various types. Eighteen patients, or 16.51 per cent., lived five years or more after operation. In every case, the diagnosis of sarcoma was made by the pathologist from the study of microscopic sections. Whenever possible, sections were obtained from the old fixed specimens and the diagnosis of sarcoma confirmed.

In conclusion, he emphasizes the value of making a differential diagnosis from benign bone tumors, syphilis, and osteomyelitis, and of excluding metastasis to the lungs. In every case the tumors should be explored before any surgical measures are attempted, and the surgical treatment should be followed by the administration of radium or Coley's toxins.—*Pio Blanco, Rochester, Minn.*

METABOLIC DISEASES.

PAGET'S DISEASE. Babonneix, Denoyelle, and Perisson. *Bull. de la Soc. Méd. des Hôpitaux*, December 2, 1921.

The authors report a case of Paget's disease in which the bony lesions involved chiefly the tibiae. The question of interest was chiefly whether it should be classified as true Paget's disease, since it did not conform to the classical type. They point out, however, the frequency with which single lesions are found and that they should be considered true Paget's disease. They agree with other French writers in accepting syphilis as the cause, although the Wasser mann reaction is frequently negative.—*P. D. Wilson, Boston.*

RELATION OF ACROMEGALY TO THYROID DISEASE, WITH STATISTICAL STUDY. J. M. Anders and H. M. Jameson. *Amer. Journal of Med. Sciences*, February, 1922.

Acromegaly is due to hyperactivity or perversion of the secretion of the pituitary body. The sella turcica enlarges as the affection develops. Acromegaly may develop with a normal pituitary, and destructive lesions of this gland may occur without symptoms of acromegaly.

Hypertrophy of the pituitary may occur after removal or disease of the thyroid. Conversely, experimental and operative hypophysectomy has produced changes in the thyroid. Without doubt these two glands exhibit points of resemblance, histological, physiological, and clinical. Two cases of acromegaly in which there was modification of the function of the thyroid are reported in detail by the authors.

There is subjoined a statistical study of 215 cases with a view to indicating the true pathological relationship between the disease of the hypophysis and the thyroid. Thirty-three per cent. of these cases of acromegaly showed evidence of associated disturbance of the thyroid function. The cases showing hypothyroidism were decidedly improved by the use of thyroid preparations in their treatment.—*F. G. Hodgson, Atlanta, Ga.*

INTERMITTENT HYDRARTHROSIS. A. L. Nielson. *Jour. A.M.A.*, February 18, 1922.

This is a case report of a rare condition with as yet no satisfactory explanation of either etiology or pathology. The patient, an unmarried woman of 38, had recurring attacks of painful swelling in her left knee, for which immobilization as well as drainage had been tried with only temporary relief. For six years the swelling occurred at irregular intervals, but since 1913 attacks of swelling occurred about every 10 or 11 days, reaching a maximum at the second day and disappearing by the fourth day. No treatment was of avail, though an elastic bandage gave some comfort. Examination of the patient was negative except as regards the knee. X-rays of joint were negative. Patient gave a history of scarlet fever in childhood, influenza in 1919, and attacks of "inflammatory rheumatism" in 1909 and 1912. Patient is able to carry on her work as stenographer and walks several blocks daily. Moderate exercise seems beneficial.—*J. A. Nutter, Montreal.*

PSEUDO-COXALGIA (OSTEOCHONDRITIS DEFORMANS JUVENILIS COXAE: QUIET HIP DISEASE). A CLINICAL AND RADIOGRAPHIC STUDY. Harry Platt. *British Jour. of Surgery*, January, 1922.

This article represents a thesis on the subject of pseudo-coxalgia based upon an analysis of three hundred hip joint conditions and of more than a thousand radiograms from the Orthopaedic Service of the Ancoats Hospital, Manchester, England. The whole question is gone into in the most comprehensive manner possible and the author is to be congratulated upon a brilliant presentation of work well done, which aims at the establishment of pseudo-coxalgia or osteochondritis deformans juvenilis coxae as a definite entity representing the reaction of the metaphyseal region of the upper end of the femur to the stimulus of an infective agent of attenuated virulence.

The condition is comparable with the arthritis deformans juvenilis coxae which is seen solely in adolescents and which represents at this age period the reaction of the hip-joint to an infective agent of a similar type. The whole clinical and radiographic picture is in accordance with this point of view, and the histological investigations in the operated cases, particularly the report by Phemister, support the explanation. In this connection a close study of hip-

joint conditions presented in Group 4 of his series, in which it is pointed out that there exist deformations of infective origin wherein flattening of the head of the femur is the outstanding feature and which should not be included in the category of pseudo-coxalgia, should be made in the accurate labeling of pseudo-coxalgia.

The whole cycle of radiographic changes is peculiar to pseudo-coxalgia alone and they precede and outlast the clinical phenomena. Deformation of the head of the femur with flattening and expansion is seen also in conditions distinct from pseudo-coxalgia in childhood, but there is no evidence to show that in these conditions the typical structural osseous changes of pseudo-coxalgia have preceded the stage of flattening. In the condition known as Köhler's disease of the tarsal scaphoid and apophysitis of the tibial tubercle, bony changes parallel to those in pseudo-coxalgia are found, and provide one of the main arguments presented by Fromme in classing the three conditions under the generic term of "late rickets." Conservative treatment has no proved influence on the train of morbid changes, but its appreciation is indicated during the stage of prominent symptoms. Operative treatment directed toward the removal of the dominant lesion has no present place in the therapeutics of the disease.

In a recent case seen at operation by the abstractor it was noted that the joint presented no variation whatever from the normal and that in the presence of the typical radiographic appearances, the head was smooth and globular as in the normal femur in virtue of its cartilaginous elements being intact. While in no way attempting to challenge the soundness of the proposed explanation as to etiology and pathogenesis presented by such an authoritative monograph, it should be observed that recent discussion with recognized authorities in Boston suggests that more extensive evidence from histological examination in these cases must be acquired before conviction as to the infective nature of pseudo-coxalgia becomes complete.

The subject is treated systematically and the claims to priority for the discovery of pseudo-coxalgia of Legg, Calvé, and Perthes receive judicial consideration. The contributions of these and other investigators have now put more than three hundred cases on record, the largest series being those of Legg and Sundt, who have collected fifty-five and seventy-five cases respectively.

In the first main section of the article the attempt is made to investigate the complete clinical life history and cycle of bony changes in a series of thirty-five cases grouped as follows: (1) Pseudo-coxalgia in childhood, eighteen cases. (2) Pseudo-coxalgia, the end-result in adult life, five cases. (3) Arthritis deformans juvenilis coxae, five cases. (4) Miscellaneous hip-joint affections in which flattening of the head of the femur is seen, coxa plana, seven cases. A complete case history is given with each case and x-ray photographs. Then is taken up the minutiae of the symptomatology and the exact nature of the radiographic changes. The whole gamut of changes in contour and internal structure which take place in the head, neck, and acetabulum are analyzed in all their phases and the author insists that the alterations in the acetabular roof have the same specific significance as the regular pattern condensation zones of the femoral neck as regards pathogenesis. The acquisition of a permanently de-

formed head is considered to be the rule in the vast majority of cases as an end-result, but with a functionally useful limb nearly as good as normal, more subject, however, to the effects of trauma, strain, and infection, leading in two cases in Group II to definite evidences of secondary arthritis.

The next main section of the paper is a critical review as to pathogenesis and factors in etiology. It is maintained that there is a mere chance association between the development of pseudo-coxalgia and the part played by trauma or by rickets. The evidence which supports the author's conception of the disease as essentially inflammatory is next developed in a masterly thesis, and considerations as to treatment complete the investigation. None of the writer's series was operated upon.—*W. A. Cochrane, Boston.*

Isolated Disease of Scaphoid Bone of Foot. A. S. Risser. *Jour. A.M.A.*, March 4, 1922.

A case report of a rare disease (called by some Köhler's disease) involving the scaphoid in children and limited to this bone. It is a lesion of obscure etiology, while knowledge of its pathology is necessarily to be obtained almost wholly from a study of the x-ray findings. The patient, a boy of six, without definite history of trauma, presented a limp and a flat foot, though he was able to continue at his play. There was great tenderness over the scaphoid, with marked redness, heat, and swelling. Transient fever was present, though this may have been due to other causes. The tonsils were the seat of repeated attacks of inflammation, while tonsillar and cervical glands were slightly swollen. The x-rays showed a scaphoid smaller in all dimensions than normal, but especially flattened antero-posteriorly. A plaster cast was used for a few days only, after which no treatment was employed. The limp and pain gradually disappeared and with it the x-ray changes. In six months there were no signs, symptoms, or changes to be seen in the x-rays.—*J. A. Nutter, Montreal.*

MISCELLANEOUS.

Contribution to the Knowledge of Bertolotti's Syndrome. Armando Albanese. *Chir. degli Organi di Movimento*, Vol. 5. No. 6, December, 1921.

Credit is due to Bertolotti for having thrown light upon a number of cases of uncertain diagnosis, often considered as sciatica and lumbago, by means of his radiological examinations. These examinations centered in the cognizance and description of thq abnormal development of the lateral processes of the fifth lumbar vertebra and of the relations of this structure to the sacrum and to the iliac bones. In this country Adams and Goldthwait have already given close attention to the sacralization of the last lumbar vertebra. Following Bertolotti's work, both the clinical and radiological observations increased very rapidly. One of the largest contributions is that of Rossi, who bases his investigation on eight hundred radiological examinations.

The author describes a series of six cases in which the radiological examination showed either unilateral or bilateral sacralization. The clinical signs

which accompanied this condition were those described by Bertolotti, and consisted in neuralgic symptoms extending on both sides of the lower extremity, having the character of sciatic or lumbo-sciatic neuralgias. The pain was of indistinct radiation and of extremely varying intensity, showing ample remissions and recrudescences. There was always difficulty in forward flexion of the trunk and in locomotion. Horizontal position did not bring relief in all cases and in no case was there a traumatic or infectious agency noted in the history.

In one case only a hypertrichosis over the sacrum was noted and a cleft in this bone was found in the x-ray picture. In two cases, however, there existed aside from the malformation of the fifth lumbar a so-called spina bifida occulta, an observation which concurs with observations of Putti, Bertolotti, and Rossi.

In addition to these observations the author has made investigations on twenty-five skeletons of fetuses or new-born children. In two of these cases there was an assimilation of the fifth lumbar to the first sacral. Looking over the literature, there is found considerable discrepancy in the data regarding the frequency of anomalies in this region, especially great in the examination of children, in whom a large part of the vertebrae is still cartilaginous. LeDouble found six sacral vertebrae only twice among two hundred cases, while Böhm, among twenty-five skeletons examined, found sacralization in twenty-two cases.

Further investigations were carried out by the author on 780 sacral bones found in the monastery of the Capuchins in Rome. Of these 780 sacra, thirty-three, or 4.2 per cent., had six vertebrae.

Among these thirty-three the author observed the existence of a rachischisis but three times.

On the other hand, only five cases showed four sacral vertebrae instead of five.

Further observation was carried out on twelve skeletons of inhabitants of the Fire Islands. The findings in this group of cases are especially interesting. In five instances there were anomalies of differentiation noted in the fifth lumbar vertebra. These anomalies consisted in sacralization and hemi-sacralization, and in three out of five cases there was a cleft of the spine, due to lack of fusion of the posterior processes of the first sacral, in two cases, and due to lack of fusion of the spinous processes of the fifth lumbar, in a third case. Especially noteworthy was the high percentage of sacralization in skeletons of this race, namely, 41.6 per cent.

While it must be admitted that the transformation of the fifth lumbar reaches back into early periods of formation of the spine, the explanation of the slow onset of the manifestations at a comparatively late period of life presupposes that a new factor arises which causes the hitherto latent condition to produce clinical symptoms.

The presence of the sacralization of the fifth lumbar in itself does not necessarily mean the appearance of Bertolotti's syndrome. By the same token it is known that numerous individuals having a cervical rib carry this through life without any clinical symptoms.

The slow appearance of the symptoms must therefore be assumed to be in connection with the developing static conditions of the vertebral column arising on the occasion of the final ossification of the lumbo-sacral region, and this usually takes place before the age of 25 to 30.

In conclusion, the author is in position to confirm from his observation not only the presence of the clinical symptoms known as Bertolotti's syndrome but also to explain their late onset beyond the age of 20.

Comparing his clinical observations with his anatomical findings on twenty-five children and on 780 sacral bones of European races on one hand, and with the twelve skeletons of the Fire Island inhabitants on the other, the frequency of rachitic clefts and of sacralization of the lumbar vertebrae in the latter is striking. While among European races not more than 4 per cent. show sacra with six vertebrae, it is found in fully 41 per cent. among the Fire Islanders. The presence of this phenomenon in such frequency among an inferior race gives rise to the suspicion that the sacralization of the fifth lumbar is a reversion to type and a form of atavism.—*A. Steindler, Iowa City, Ia.*

ACUTE OSTEOMYELITIS. I. Cohn. *New Orleans Med. and Surg. Jour.*, January, 1922.

Osteomyelitis is a crippling disease when not recognized early and should be diagnosed early enough to prevent the formation of sequestra. The paper is based on the following:

1. Osteomyelitis is a blood-borne disease.
2. It localizes primarily in the medullary canal.
3. There are no early x-ray findings on which a diagnosis can be based.
4. Early diagnosis must be made if we expect to cure the patient without prolonged treatment and multiple operations.
5. The early operative findings may be only a fat necrosis of the medullary contents without frank pus.
6. Early operation should give almost instant relief from pain, a subsidence of temperature, and an early recovery, with perfect restoration of function.
7. Early operation should not be followed by sequestrum formation.
8. Early diagnosis and operation should remove osteomyelitis from the class of chronically disabling diseases.

The x-ray is of negative value and the diagnosis should be made before it is possible to make anything out in the skiagraph. When the diagnosis is made operation should be done at once, preferably with motor-driven instruments. The medullary canal should be opened, even if pus is found under the periosteum, because it is sure that the infection has reached the cortex through the Haversian system. The use of the curette is decried. Four cases are reported.—*Edward S. Hatch, New Orleans, La.*

OSTEOCHONDRITIS OF RIBS FOLLOWING TYPHUS FEVER AND ITS TREATMENT BY INJECTIONS OF IODINE. Nadine Dobrovolskaia (Prof. de Chirurgie, Univ. de Voronège, Russie). *Presse Médicale*, December 3, 1921.

Lesions of the above nature are well known among the complications of typhoid and paratyphoid fevers. However, Dobrovolskaia has been unable to find any mention of them among the described complications of typhus fever. They were observed, nevertheless, in numerous cases during the 1919-1920 epidemic of typhus among the refugees of Southern Russia, and they proved very

refractory to ordinary methods of treatment. They developed during the period of convalescence, or from several weeks to several months after the fever. Clinical features agreed with those of similar lesions following typhoid fevers, often with severe pain in the indurated lesions. Bacteriological study was hampered by conditions under which the work was done. Pus from closed abscesses was sterile. Smears were negative for tubercle bacillus. Wassermann test negative, except in a few cases.

The following methods of treatment were worked out in the hospital where the author studied them, in Egypt. General measures included rest, open-air life, forced feeding, symptomatic medication. Heliotherapy, proceeding gradually, from initial small dosage, for the majority of the cases. As these were seldom sufficient to effect a cure of the rib lesions, the following procedure was added. As proposed and used, with good results, by Hotz and Kanevskaia, in Russia, in cases of surgical tuberculosis, intramuscular injections of iodine with iodoform. The preparation—10 per cent. tincture iodine with 10 per cent. iodoform in paraffin oil—is freshly made before using, and is injected under local anaesthesia, into the buttock, with an initial dose of 3 cc., increasing to 10 cc., at intervals of one week. According to Hotz's theory, fat-splitting ferments are set free in the lymphocytosis provoked by the iodine injections, making more vulnerable to attack organisms like those of tuberculosis and leprosy. In addition to the injections, alternating areas on various parts of the body are painted with iodine every few days. Local treatment is simple; aseptic dressings, soap poultice, or camphorated oil for painful indurations.

From his personal observations Dobrovolskaia believes these post-typhus lesions differ in no important respect from the post-typhoid; that, admitting the probability that in either group the specific organism of that group is a factor, such lesions develop only in favorable soil, such as furnished by latent tuberculosis, or occasionally syphilis. The foregoing method of treatment by attacking one of these agents renders the other more subject to control. The results have been definite—complete cure in a majority of the cases; convalescence established in the more stubborn cases. Treatment is protracted, but hospitalization is not essential. Care is required in dealing with patients who have an idiosyncrasy for iodine. When indicated, antispecific treatment is demanded as well.—*Roades Fayerweather, Baltimore, Md.*

RESEARCH ON THE DEVELOPMENT OF THE JOINTS. Giulio Faldino. *Chir. degli Organi di Movimento*, Vol. 5, No. 6, December, 1921.

The study of different embryos proved that beginning with the first phases of development there exist certain articulations which develop normally in their differentiation of an epiphysis and articular cavity, while others in the same embryos remain at this time absolutely undifferentiated. Among the first to become differentiated are the shoulder-joint, the elbow-joint, the metacarpophalangeal joints, the hip-joint, and the tibio-tarsal joints. There are undoubtedly joints which are necessarily in function in very early stages of embryonal life, and, on the other hand, others in which no function appears during this stage. The author has observed that differentiation occurs much earlier in those joints which in embryonal life maintain a flexion position. It is obvious,

therefore, that something outside of the joint is acting which determines differentiation, and this agency he believes to be muscle action. The tendons develop very early, and in regard to differentiation the author has observed that the tendons of the flexor muscles precede considerably those of the extensors. This difference in development of tendons existing among the diverse groups must serve as an explanation of the fact that some articulations develop early, while others lag behind. Comparing the time of development of these organs which supply the mechanism of joint motion with the development of the joint itself, one may observe that no joint develops prior to the development of its own tendons, and that the development of the tendons themselves to a state in which they are able to function seems to be a prerequisite to the development of their respective joints.

Although direct proofs of the function of the muscle tissue of the locomotor apparatus in such earlier periods of intrauterine life are missing, one may concede with sufficient certainty that such function exists, from analogy with the activity of the myocardium in very young embryos.

Other important data which favor the mechanical theory of differentiation of joints are found in the study of the intermediate cartilage discs which precede the formation of the joint cavity. In the first phases of development the cells of this structure are large, vascular, and resemble those of the primitive mesenchyme. At a later period the intermediate disc becomes thinned out and its cells become differentiated by assuming an oblong or depressed shape, aligning themselves perpendicularly to the axis of the articulation.

All this indicates with probability that the muscle action must have a considerable influence upon the formation of the mesenchymatous tissue which forms the primitive intermediate disc, and it is hard to explain the formation of the cavity itself without calling upon muscle traction.

One must therefore conclude that while the formation of the articulations themselves in their very first development is subordinated to the phylogenetic laws, in the course of development, however, the functional modifications are influenced by mechanical factors, among which the function of the locomotor tissues surrounding the joints is most prominent.

The articulations develop from mesenchymatous tissue which represents the first buds of the growing extremities. The tissue forming the intermediate disc is lined by a connective tissue membrane which very early develops from the primitive blastema. Following the development of the articular capsule, the external and internal articular ligaments become differentiated.

Summary: The time of differentiation is not the same for all articulations, and those articulations precede in development which are normally in flexed position. The differentiation of the articulation itself is always preceded by the differentiation of its corresponding muscular apparatus. The formation of the joint cavity occurs almost simultaneously with the differentiation of the articular ends, and occurs by a process of differentiation of the embryonal connective tissue without the process of fatty degeneration or liquefaction. Certain free portions of the intermediate disc give rise to the later formation of synovial villi.

The cellular re-lining of the internal surfaces of the capsule is again a dif-

ferentiation of the connective tissue following mechanical influences. In general, the development of the articulations may be considered as occurring under phylogenetic laws only in the very first stages of differentiation. In the following stages, however, it is bound to the action of mechanical factors and to the function of the muscular apparatus surrounding the joint.—*A. Steindler, Iowa City, Ia.*

CIRCULATORY DISTURBANCES OF THE FEET. Emil S. Geist. *Minnesota Medicine*, February, 1922, page 98.

From a series of 500 consecutive cases of "foot complaint," there are presented 67 cases of circulatory disturbances. The 23 cases of venous stasis are mentioned in passing, but the 42 cases of disturbed circulation due to impaired arterial circulation are taken up in detail. Of these 42, 29 were male and 13 female; ages ranged mostly between 45 and 65; there were 27 Americans, 13 Jews, 1 German, and 1 Scandinavian.

Congenitally small blood-vessels, as well as various toxic agents, were held responsible in most cases. The excessive use of coffee, tobacco, and alcohol figured. Syphilis, diabetes, and exposure to cold are also mentioned. The patients complained of pain on use, pain at night, cramps on slight exertion, and especially that the wearing of braces increased the pain. The feet were often found to be somewhat cyanotic and at times edematous. In not one case could the pulsation in the dorsalis pedis artery be felt, and in more marked cases it was not possible to detect pulsation in the posterior tibial.

The following classification of arterial lesions of the foot is presented:

1. Congenitally small arteries. Under this heading the case of a girl, age 14, is reported.

2. Arterial spasm. Fourteen cases were grouped under this type. A case is reported of a male Jew, aged 58, who complained of cold feet and cramping after walking three or four blocks.

3. Arteriosclerosis of the feet. Twenty-three cases were grouped here. The symptoms are said to be more persistent and more severe than in arterial spasm. The calcareous arterial deposits are often shown by the roentgenogram.

4. Thromboangiitis obliterans. Two cases were placed in this group, and both are reported. The author thinks it possible that this is just the final stage of some of the cases of arterial spasm and arteriosclerosis. Jews are most frequently affected. Extreme thrombosis of the arteries of the foot and even the leg is present. Amputation is often necessary.

Under treatment there is mentioned: Sodium nitrite and potassium iodide, alternate hot and cold foot baths, woolen stockings, abstinence from coffee and tobacco, heliotherapy, and rest to the feet.—*H. T. Jones, Rochester, Minn.*

THE TREATMENT OF STRUCTURAL SCOLIOSIS AT THE MASSACHUSETTS GENERAL HOSPITAL. Armin Klein. *Jour. A.M.A.*, February 11, 1922.

Severe structural scoliosis (non-paralytic) is being treated on the assumption that it cannot, with our present knowledge of the subject, be cured. Over-

correction is not attempted; apparent symmetry and the absence of obvious deformity are aimed at. The patients are not kept in hospital more than three hours a week, but are allowed to continue their usual duties at school or work, and are encouraged to play whatever games they can, hampered by a plaster jacket weighing five to seven pounds.

After preliminary photographs, x-rays, and measurements, exercises are begun. No apparatus is used, and the exercises are repeated two or three times a day at home. The exercises mobilize the unused and tightened muscles and ligaments of the trunk, enabling the patient to localize his control over his respiratory muscles. It is on this force, carefully nurtured beforehand, that we rely for correction of the patient's asymmetry. After one to six months' exercises a corrective jacket is applied. This is done on an Abbott frame, the patient supine, the spine somewhat flexed, the shoulder girdle rotated towards the side of the convexity of the spinal curve, while the pelvic girdle is rotated in the opposite direction. In a right dorsal, left lumbar curve the shoulders are rotated towards the right (pushing forward the right rib prominence) and the pelvis in the opposite direction. This lessens the right rib prominence and at the same time tends to fill out the left-sided rib concavity. It is to be noted that with the pelvis fixed and the lumbar spine capable of but little rotation the rotative force both above and below is very largely concentrated on the dorsal area of the spine. The corrective jackets have windows over the concave areas and felt pads are applied every week to increase the correction. Casts are maintained until no longer efficacious, which usually occurs in a month, while repetition of casts goes on so long as improvement is shown. A removable cast is then made, with hinges behind and straps and buckles in front. Then for a few months exercises are given, to be followed by another series of permanent rotation jackets for still further correction. When the maximum of correction has been obtained from jackets in the rotated position other jackets are applied without rotation, by which the hump is attacked still further. These are followed by a brace worn over a period of years and accompanied by exercises, while Wolff's law of bone transformation may take effect.—*J. A. Nutter, Montreal.*

PSEUDO-PARAPLEGIA RESULTING FROM DOUBLE TABETIC ARTHROPATHY OF THE HIPS. André Léri and Lerond. *Bull. de la Soc. de Méd. des Hôpitaux,* November 25, 1921.

The authors report a case which had wrongly carried the diagnosis of paraplegia for twenty years. The paralytic symptoms were due to a tabetic arthropathy involving both hips, which had a very abrupt onset. The destruction of the head and neck of the femora was great, with ascent of the trochanters, thus destroying the leverage powers of the hip muscles. The knee jerks were absent, there was loss of deep muscle sense, and typical Argyll-Robertson pupils, but these had been overlooked on account of the apparent paralysis of the lower extremities.—*P. D. Wilson, Boston.*

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Also a pair of triple-action ratchet wrenches for bending and twisting Thomas Hip Splints. These wrenches were specially made and are the only pair in this country. Cost $58.

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The Journal of Bone & Joint Surgery

HEMORRHAGIC OSTEOMYELITIS.*

BY GEORGE BARRIE, M.D., F.A.C.S., NEW YORK CITY.

The importance of the lesion in bone termed Hemorrhagic Osteomyelitis appears to be now well recognized, its benign condition quite established, and its characteristic features of a mild inflammatory affection definitely proven by the gross and microscopic criteria presented by the process.

The purpose of this paper is to emphasize particularly the above facts, rather than to offer anything especially new at this time, and to give in brief outline our present-day knowledge which careful study of the lesion has gradually developed.

Until ten years ago there was universal acceptance of the dogmatic assertions that this pathologic process in bone was malignant and that it required the standardized operative surgical measures accorded neoplastic disease for its eradication. Amputations of limbs were commonly resorted to and resultant cures heralded as achievements in overcoming malignancy. Many statistical tables published in the past reporting cures of bone sarcoma owe their greatly increased percentage of cures to the inclusion in such statistical tables of lesions in bone which we know now were not malignant or even blastomatous. All scientific

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

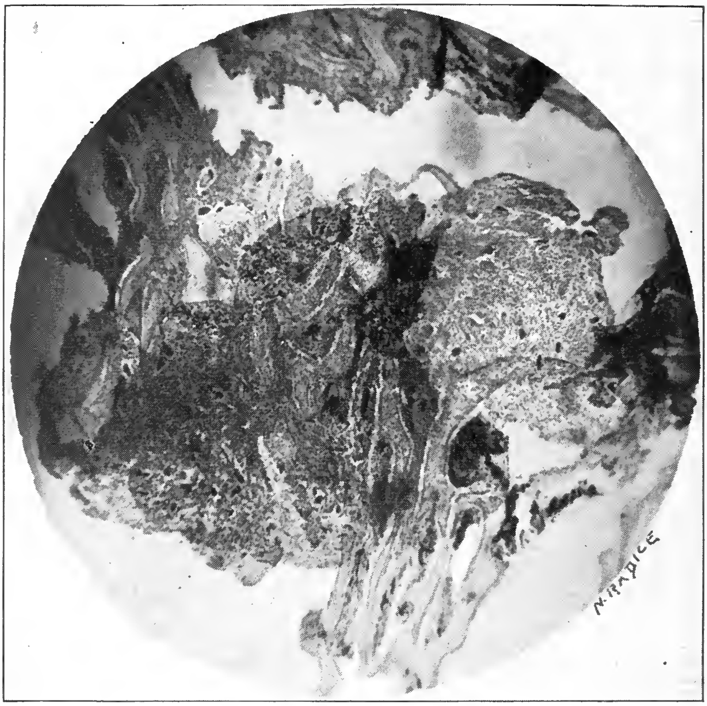

FIGURE 1.—Photomicrograph, low power, showing a typical microscopic picture of hemorrhagic osteomyelitis, miscalled giant-cell sarcoma and giant-cell tumor. Note the basic granulation tissue structure, scattered scavenger giant cells, and disintegrated bone.

methods of search and investigation demonstrate that this process in spongy bone, heretofore described as sarcoma, parallels and coincides in all its stages with the varying phases of non-suppurative inflammatory change. In spite of such evidence there are many surgeons who, even to-day, regard these lesions with great suspicion and adopt the slogan "when in doubt eradicate," which they certainly accomplish when they amputate portions of, or whole, extremities.

This deplorable attitude is due, in large measure, to the expression of opinion by many surgeons, pathologists, and radiologists that these benign inflammatory masses, found in destroyed bone areas, are neoplastic growths, which they term either giant-cell sarcomata or giant-cell tumors. The presenting evidence in all such cases, of an effort at regenerative repair and restoration of structure, appears to be quite overlooked or ignored.

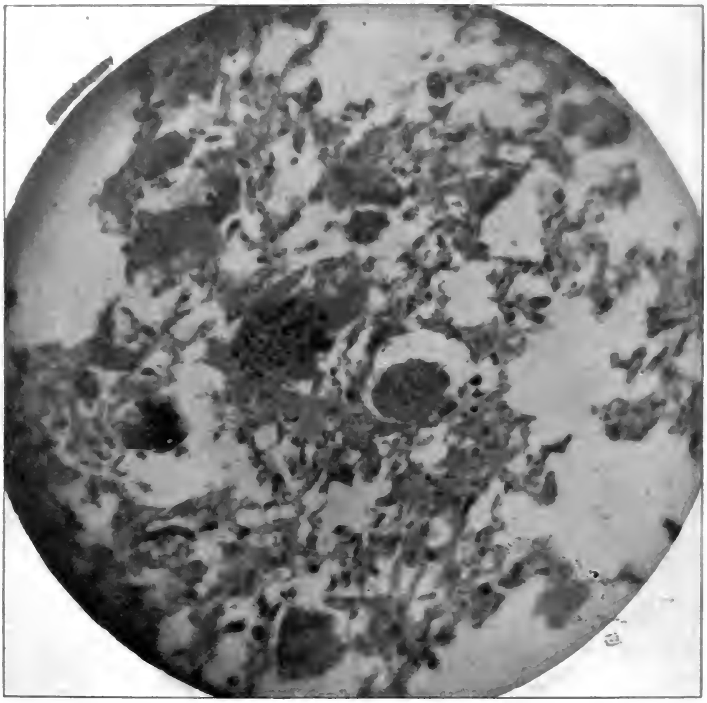

FIGURE 2.—Photomicrograph, high power, showing in detail the scavenger (foreign body) cells. These cells are sometimes present in great numbers in localized areas of hemorrhagic osteomyelitis containing sterile débris. Note the number of nuclei within the cell, the uniform size and shape of the nuclei, the absence of fibrils and mitotic figures, all of which are in contra-distinction to the tumor giant cell. Scavenger giant cells arise from fusion of endothelial cells. They enclose, or absorb, foreign particles in the tissues.

Pathologists and surgeons, without exception, when they encounter tissue formation of similar structure occupying areas that have been destroyed in soft parts, have no hesitation in making diagnoses of exuberant inflammatory granulations. When exactly the same type of structure, both macroscopically and microscopically, presents itself as a mass within an enclosed bony shell, it is erroneously regarded as a neoplasm. In order to bolster up this theory of neoplasia, the innocent scavenger giant cells found in these lesions have been seized upon as the offenders, without any basic evidence whatever to show they are even a factor in tumor growth.

It has also been interesting to note that in numerous instances when an area of osteolysis is exposed where destruction does not exceed the

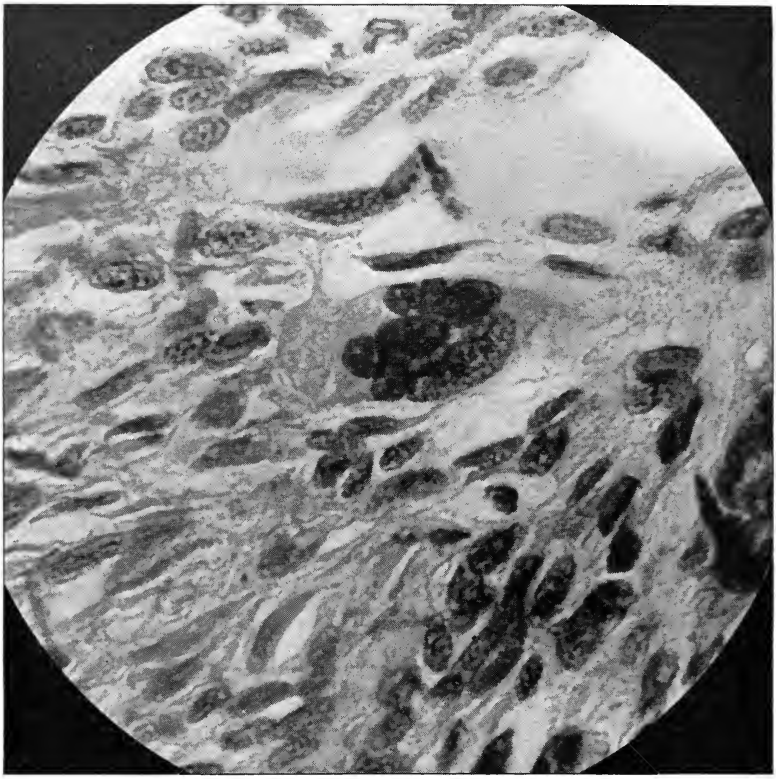

FIGURE 3.—Photomicrograph, high power, of a tumor giant cell. This type cell is never found in hemorrhagic osteomyelitis. It arises from multiple mitoses and denotes malignancy. Compare with the scavenger cell marked Figure 2. Note the few very large irregular lobulated nuclei and definitely different picture the tumor giant cell presents.

size of a cherry or plum, radiologists and surgeons seem quite generally to regard such lesions as bone cysts, notwithstanding the fact that the destroyed area at operation may be found filled with solid granulation tissue, and frequently without any appearance of lining membrane. Should the area of osteolysis happen to be the size of an orange, containing contents of exactly the same type of replacement granulation tissue, and also presenting a histologic picture exactly similar to the smaller lesions, there seems to be no hesitancy in describing the process as a giant-cell sarcoma or a giant-cell tumor. The inaccuracy in using such terms to describe these masses of regenerative tissue cannot be too strongly emphasized, because the affections never contain what are rec-

FIGURE 4.—Hemorrhagic osteomyelitis lower end right tibia. Male, age 38. Before operation.

ognized as giant tumor cells. On the other hand, scavenger, or foreign body, cells may be quite numerous in localized areas of the process. The presence of the latter indicates nature's method of removing the sterile débris contained in the lesions. In areas where regeneration and metaplasia are progressing, few or no giant cells are found. There is never a uniform picture of scavenger giant-cell content or arrangement in any of these lesions.

A recent paper on bone sarcoma, published by Greenough, Simmons and Harmer, brings out very well an important phase of the subject, as follows:

"Tumor giant cells are to be distinguished sharply from the typical foreign-body cells of endothelial origin which are encountered so frequently in all bone diseases, benign or malignant, and which are of practically no significance from the tumor point of view, however much they may impress themselves upon the observer in the microscopic sec-

FIGURE 5.—End-result 3 years after curettage by H. L. Taylor.

tions of the tissue, as in the miscalled 'giant cell sarcoma' of the epulis type.''

The proponents of a neoplastic or blastomatous theory of origin for the affection termed hemorrhagic osteomyelitis are in a very vulnerable position when they pin their faith upon the foreign body or scavenger giant-cell content as being factors in producing such lesions. From the time of Nélaton, in 1852, to the present moment no demonstrable proof has been adduced that giant cells, of the type found in these processes, are tumor-forming cells. Their function, however, as scavengers for the removal of sterile débris, is well recognized. Numerous studies and investigations leave no room for doubt that the functions of such cells are wholly scavenger. When their presence is observed in true blastomata, the type of cell that produces and forms the neoplasm itself should describe the process, and not the innocent scavenger giant cells. As has been pointed out in other papers covering the subject, the term giant-cell sarcoma and giant-cell tumor are misnomers, which should be discontinued. The tissue mass is not a result of giant-cell growth or of giant-cell origin.

FIGURE 6.—Hemorrhagic osteomyelitis lower end left tibia. Male, age 18 years. Before operation.

A knowledge of the inflammatory picture of the bone pathology of these cases which establishes their benign course should insure conservative surgical treatment. Much of the radical surgery that has been performed for the cure of these conditions rests at the door of pathologists, whose reports of malignancy or neoplasia have been quite general in the past. When they decide to drop the use of such terms as giant-cell sarcoma and giant-cell tumor in describing the process, and note instead the criteria the cellular pictures present of a low-grade inflammation or osteomyelitis, surgeons will recognize the benign character of the lesion and institute conservative methods of treatment.

Hemorrhagic osteomyelitis should not be regarded as a lesion of degenerative or destructive intent, but rather as nature's effort to form primary replacement tissue in a previously destroyed bone area. Such attempt may finally progress to full architectural restoration of bony

FIGURE 7.—End-result four years after curettage by Barrie.

substance. Partial success only exhibits itself in the metaplasia of the granulation tissue into fibrous structure, forming fibro-cystic processes in bone. Failure or arrest of repair appears to be due to a deficiency in the chemotactic properties of the blood which prevents the formation of sufficient collagen for the further activity of fibroblastic and osteoblastic structure. It is this condition of failure or arrest that gives the pathologic picture of the lesion termed hemorrhagic osteomyelitis. All evidence confirms the inflammatory origin of these processes, which are formed for the purpose of repairing previously destroyed areas in bone.

Etiology: Careful investigation has shown that about 75 per cent. of the solitary lesions trace their cause to bone trauma, recent or remote. Other factors producing localized areas of osteolysis may quite certainly be due to hematogenous infections of low-grade virulency, to endocrinal glandular disturbance or to bone malnutrition. Indeed, this seems to be the only explanation for the appearance of the very rare multiple lesions. Bacteria have never been isolated from the removed tissues in

FIGURE 8.—Hemorrhagic osteomyelitis phalanx. Female, age 18 years. End-result two and one-half years after curettage by S. E. Twinch.

FIGURE 9.—Hemorrhagic osteomyelitis upper end right femur. Female, age 9 years. Before operation.

FIGURE 10.—End-result six years after curettage and filling cavity with autogenous bone shavings by Barrie.

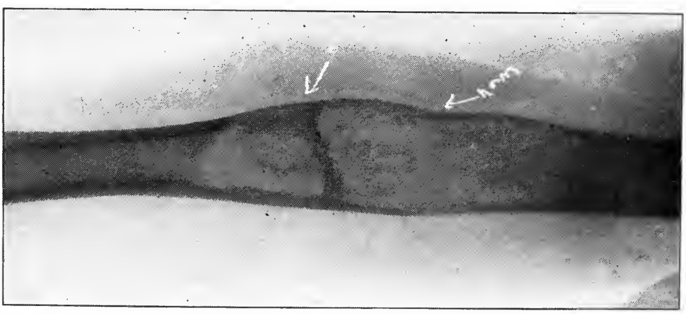

FIGURE 11.—Hemorrhagic osteomyelitis left humerus. Female, age 19 years. Fracture two years ago united and well in six weeks. Ré-fracture (pathologic) one week ago. Old and recent fractures noted in picture. Curettage and fillings with Mosetig-Moorhof paste by M. Rehling.

any of the processes. In our experience the solitary lesions have been found at all ages, more frequently, however, during the first and second decades of life. In neither sex are the lesions predominant. Their duration may be months or years.

FIGURE 12.—X-ray taken three months after operation.

FIGURE 13.—X-ray of Rehling's case two years after curettage and bone filling.

The lower extremities have been the site of election in the proportion of three to one. The femur has been most frequently involved of all bones, the upper and lower ends being equally affected; next in order have been the tibia, fibula, radius, humerus, etc.

Symptoms: The symptoms are usually mild unless the lesion has been long-standing and is quite large. Symptoms also depend, in some degree, upon the location of the focus. Lesions in the lower extremity practically always cause limping. Where the process is found near a joint, some limitation of motion in that joint is always present.

The sense of pain is never constant. In the smaller lesions it is apt to be slight, and may be absent until pressure over the site is exerted. Pressure always elicits tenderness and pain. All signs of acute inflammation are lacking.

Pathology: The gross pathology exhibits a dominant picture of highly vascular granulation tissue that composes the mass filling the bone

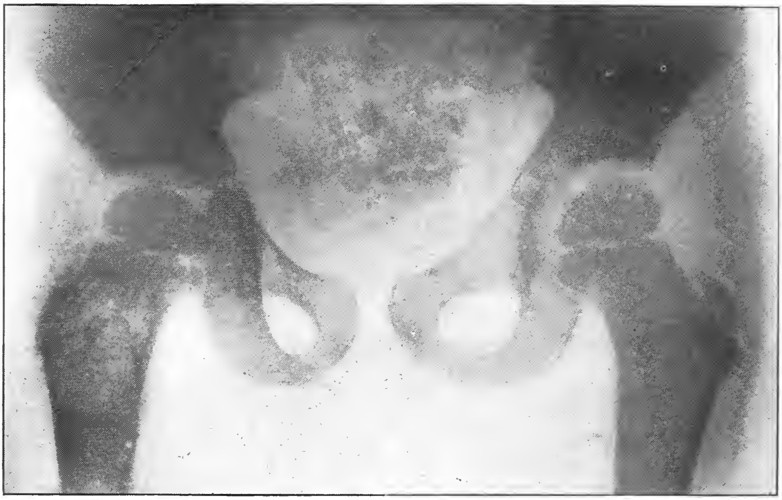

FIGURE 14.—Hemorrhagic osteomyelitis upper end right femur. Male, age 6 years. Before operation.

cavity. There may be observed within the lesion localized fibrous metaplastic areas. There are also frequently present numerous scattered hyaline bodies in and around the hemorrhagic mass. The microscopic picture is definitely heterogenous. It duplicates in all respects the histopathology of granulation tissue. In some sections the scavenger giant cells are very numerous, in others few or none are found. No uniformity, however, is maintained in their distribution.

Invasion, as understood to pertain to malignancy, is not observed. There are altogether absent the essential features of sarcomatous structure in which the cells of origin reproduce their kind and go on to the formation of true blastomata. The potentialities for tumor formation in the regenerative mass do not seem to be any greater than may occur in other inflammatory tissues. It is all-important to state, and the fact cannot be too strongly stressed, that true tumor giant cells are never found in these processes.

Diagnosis: A pre-operative definite diagnosis is impossible without the aid of the x-ray. The history and clinical picture in these cases simulates many other pathologic conditions of a chronic character affecting the bone.

Lesions have been personally observed in 42 cases, as early as 18 months of life and up to 63 years.

FIGURE 15.—End-result eight years after curettage by Barrie.

The area of osteolysis, exhibited by the x-ray, usually shows a clear-cut rounded or oval spot in the cortex. When the lesion is large this rounded or oval clear-cut appearance may be less sharply defined. Expansion is observed without breaking through the periosteum. Any chronic lesion in which the periosteum has been broken through should be regarded with suspicion as to malignancy, unless it is known to be definitely suppurative.

In our experience, in no instance has a hemorrhagic osteomyelitis penetrated through the cartilaginous structure separating the epiphysis from the diaphysis in children.

In reaching pre-operative diagnostic conclusions we are aided by the chronicity of the lesion, its lack of severe symptoms, the greater frequency of its appearance during the first two decades of life, its clear-cut and non-invasive outline in the x-ray picture, and its non-penetration through epiphyseal cartilage. The lesion is more frequently observed near the ends of the long bones. It may, however, occur in any portion of the shaft.

Figure 16.—Hemorrhagic osteomyelitis upper end humerus. Female, age 20 years. X-ray after curettage and graft insert by H. L. Taylor.

Figure 17.—Photo showing motion in shoulder-joint three years after operation.

FIGURE 18.—End-result four and one-half years after operation.

The gross appearance of the lesion during operative interference is typical of exuberant hemorrhagic granulations, and finally the microscopic picture, exhibiting no evidence of autonomous growth, is conclusive in ruling out blastomata.

Differential Diagnosis: Differential diagnoses from acute inflammatory infections in bone and highly malignant processes are easily arrived at by a correlation of the clinical picture and x-ray findings.

The localized chronic bone abscess, true bone cyst, myxoma, or early slow-growing fibro-sarcoma, may require, in addition to the clinical and x-ray findings, the gross pathology observed at operation to establish a definite diagnosis. The picture of a highly vascular granulation tissue mass appearing in an area of spongy bone is almost pathognomonic of a hemorrhagic osteomyelitis, but must not be regarded as positive.

The writer has observed one case in which the gross pathology of the lesion simulated a hemorrhagic osteomyelitis. In this patient, however, the clinical history and examination with x-ray findings, independent of the gross pathology, fully corroborated the picture of a highly malignant neoplasm. This was further confirmed by a microscopic picture of definite cellular riot and true tumor giant-cell content.

Treatment: Treatment consists in removing all exuberant granula-

tions that fill the destroyed bone area and thoroughly curetting the cavity wall. Stimulation for final reproduction of normal bone tissue seems to be aided by swabbing with tincture of iodine. In cases where severe hemorrhage follows curettage, firm packing may be necessary for forty-eight hours to control it, before final closure of the operative wound is attempted. Large cavities are aided in the progress of repair by filling with bone graft, chips, shavings, or the use of the Mosetig-Moorhof *plombierung*.

Up to the present time these simple operative measures have proven quite satisfactory. The use of radium or x-ray has the disadvantage of preventing the visible inspection of tissue in non-operative cases, or if the lesions are opened for such treatment, immediate closure is impossible. In all cases operated upon, primary healing has occurred. No recurrences have been observed. The end-results in the patients who have been successfully followed have been excellent. The illustrations show the end-results in some of the cases.

I am under obligation to Doctors H. L. Taylor, M. Rehling, and S. A. Twinch for the privilege of presenting their cases.

DISCUSSION OF DR. BARRIE'S PAPER.

Dr. E. W. Ryerson, Chicago: The importance of such work as this of Dr. Barrie is, of course, self-evident. It is of the utmost interest and importance for us to be able to differentiate these various bone—I do not know whether to call them growths or not—appearances. Apparently these conditions are becoming more frequent. We see more cases every year where cavities or areas of osteoporosis exist in the bone. All of these, in my opinion, should be submitted to immediate operation, and then the unfortunate clinician is apt to be up against it. Not long ago I saw a young medical student from a city not far from Chicago, with pain in his shoulder. He was seen by some excellent orthopaedic men who thought a subdeltoid bursitis existed. When he came to Chicago there was a picture exactly similar to one of these pictures we have seen this morning. It seemed to me that if we could show this was a hemorrhagic arthritis it would be of great benefit to the young man. Consequently the shoulder was opened, and a large amount of tissue, corresponding microscopically to what Dr. Barrie found, was removed. A diagnosis of small round-cell sarcoma of a highly malignant character was immediately returned. I asked our leading surgeon to see the case and he considered from the microscopic sections and from the history that it was a giant-cell tumor. The entire area had been carefully cleaned out and what appeared to be the lining membrane removed, and the cavity filled with iodin. He went back to the place where he was studying and I did not see him for three or four months. When he came back the upper end of the humerus was as large as my fist. It looked like a rapidly growing giant-cell tumor, if such things exist. I was not willing to take the responsibility and asked him to go to see Bloodgood at Baltimore. Bloodgood telegraphed me that it was a giant-cell affair. Where is the ordinary hard-working orthopaedic man who does not know much pathology

going to get off? I do not know what Dr. Bloodgood has finally done for the man. I have had a dozen cases in the last few years where these simple shaft affairs occurred. Some of them looked exactly like new growths of the malignant type. I am beginning to be in favor of a radical removal, not by amputation, but by the removal of as much of this tissue and the surrounding areas as possible, and then making a careful pathologic investigation. I have not yet seen what I could absolutely assure myself was an hemorrhagic osteomyelitis. In all of these cases the differentiation from osteitis fibrosa is very difficult.

The etiology is not at all clear to me from Dr. Barrie's investigation. It is difficult to believe that a simple trauma to bone could produce the same condition in the bone as some low-grade infection. It is not altogether clear as to where this infection comes from. I think the whole subject is worthy of investigation because it means the saving of limbs in many cases and the saving of lives in many others. The pathologists are apparently not well informed on hemorrhagic osteomyelitis. Some have not heard of it. When the confusion is as great as it is among the various pathologists whom I happen to employ to make diagnoses for me, I certainly do not feel that any conservative measures should be employed in these doubtful cases.

Dr. Reginald Sayre, New York: I feel very much as Dr. Ryerson does. I am not certain when I see one of these cases just what it is. The first one I encountered was some six or seven years ago. This girl struck her knee and thought she had simply bruised it. After a short time it became very tender. She was running down hill, and the x-ray showed very much the same picture as Dr. Barrie has shown in the upper end of the tibia. I scooped out this cavity and the pathologist said it was a spindle-cell sarcoma. Dr. Bissell put some radium in the cavity. It looked just perfectly lifeless. He put the radium in again and nothing happened. One day the house surgeon stuffed the cavity full of iodoform gauze. I had carefully refrained from putting in anything but plain gauze while the radium was being inserted. When he put in the iodoform gauze the cavity cleared up and the girl got better. Dr. Barrie looked at the x-ray and said the pathologist did not know what he was talking about; that it was one of his hemorrhagic osteomyelitis cases. Dr. Bissell felt his radium cured her and the house surgeon thought the iodoform did it. I was of a quite open mind.

A few years ago another patient came in with a swelling on the knee from a bump on the walk. The x-ray showed the typical appearance of those cases Dr. Barrie showed. I looked at the case and said it was an hemorrhagic osteomyelitis. The x-ray man said it was malignant and should have x-ray treatments. It was subjected to x-ray treatment and it was apparently like dissolving a cake of ice in July. The cortical outline was dissolving and it looked as though it would press through the skin and he advised amputation. I advised scooping out the diseased portion. There was an uneventful healing and the man is walking about today with a good limb.

I have had four or five cases where I did not operate and had good results. There was one small boy with a cyst in the upper end of the femur, whom I presented some years ago at the section of the Academy of Medicine. We treated him with a hip splint. Last year his mother showed me a clipping from a paper saying he had won a foot race in high school. The x-ray shows a gradual change of the cyst into a perfectly normal leg.

Last December a child was sent to me who had symptoms of hip disease. The x-ray showed a cyst of this femur. I treated him this way. A short time ago he came back with a fracture through the cyst. While in the hospital an

x-ray picture was taken. To my great surprise this cyst in the last month has filled out with bone. This brought to my mind the possbility of some of these cyst cases being treated by puncture so as to revivify them. What I presume happened was that the fracture allowed new blood to flow in, just as after cutting the edges of an ulcer of the shin the ulcer will heal. Within two months' time this cyst has completely changed its appearance and the picture of the leg looks like these pictures of operated cysts which Dr. Barrie has shown.

Dr. Sidney H. Cone, Baltimore: I want to say a word to put clearly before you a number of the conflicts which come up between laboratory men and surgeons. During the last two years there has been a great deal of work done in bone and joint conditions in the anatomical and pathological laboratory, particularly by Jordan of the University of Virginia, and Bast of Wisconsin, distinguishing the particular kind of cells found in bone and which will help explain such conditions as Dr. Barrie has described. I feel that inasmuch as we also have difficulty in a few conditions in pathology in its relation to general surgery there are some things which cannot be cleared at once. There is work going on now which will clear up some of the pathology of these hemorrhagic osteomyelitides, particularly in reference to the giant cells found therein.

Dr. S. Fosdick Jones, Denver: I have been particularly interested in this paper of Dr. Barrie, because I believe it is just the type of paper from which we receive a great deal of valuable information. It is difficult at times, even with the best of skiagraphic plates, to arrive at a definite diagnosis of these rarer forms of bone lesions, and the pathological examination is, to my mind, most essential in differentiating and arriving at an accurate diagnosis when these more obscure bone diseases present themselves. For example, in cases of Brodie's abscess, which was recently so well described by Dr. MacWilliams of New York, the skiagraphs of Dr. Barrie's case might well suggest such a condition.

In considering the differential diagnosis of bone lesions viewed from the standpoint of radiography alone, the following two cases will serve to illustrate some of the difficulties which one may encounter.

Some years ago a railroad clerk came under my observation, giving a history of injury to the shoulder from being thrown violently against the side of a postal railroad car. The clinical examination suggested at once the diagnosis of a typical case of subdeltoid bursitis. The first x-ray taken at the time of the examination was negative, and no bony lesion was seen. Immobilization in the Codman abduction splint at first, for a period of two weeks, gave great relief from the acute and painful symptoms. After removal of the splint, three weeks after the injury, the pain returned and a second x-ray was taken which again showed no bone involvement. The abduction splint was continued for another three weeks, but the local pain over the deltoid bursa continued and a slight swelling appeared in the region of the acromion process. A third skiagraph taken about nine weeks after the injury clearly demonstrated an osteal sarcoma, requiring a radical operation.

The second case was that of a girl of seventeen years who was sent to me for a suspected tuberculosis of the knee-joint, in which the x-ray was negative at the time of the first examination. This case has been previously reported by me before this Association. Aspiration of the joint showed a bloody fluid, with no pus, and upon opening the knee-joint, a definite osteal sarcoma involving the lower end of the femur and condyles was present. A mid-thigh

amputation was performed, but ten months later the patient died of metastasis involving both lungs and pleura.

Osteomyelitis will not infrequently give the same picture by x-ray that is seen in early cases of osteitis fibrosa cystica, or in sclerosing non-suppurative osteomyelitis, and early sarcoma is difficult to demonstrate from early bone rarefactions due to some forms of benign bone diseases. Early bone sarcoma and early bone tuberculosis are not infrequently difficult to diagnose from a radiographic view.

Dr. George Barrie, New York City: I wish to thank the gentlemen who discussed the paper.

STUDIES ON EXPERIMENTAL RICKETS.*

BY P. G. SHIPLEY, M.D., BALTIMORE, MD.

RICKETS has become so familiar in hospitals and dispensaries that in many cases no attention is paid to the disease. The spontaneous recovery of many of the patients has induced a *laissez-faire* policy in its treatment on the part of many physicians.

For the past forty years sporadic attempts have been made to reproduce rickets in laboratory animals by means of the various agents which have been suspected of causing the disease. Some investigators have tried to reproduce it by extirpation of various endocrine glands. Others have tried keeping their animals under bad hygienic conditions, or infecting them with micro-organisms. Perhaps, however, the greatest number have attempted to reproduce rickets by feeding their animals on diets which were in one way or another unsatisfactory. The lack of uniformity in their results is easily explainable in the light of our present knowledge of nutrition. It has only very recently become possible to analyze a diet with sufficient accuracy to know how and to what degree it deviates from an optimal standard. For example, an animal which is fed on starch and horse meat is, as it was thought fifteen years ago, receiving a diet which is low in calcium, but we know now that such a diet is also deficient in fat-soluble A and water-soluble B, and is relatively high in phosphates. Therefore, attempts in the past to produce rickets by the diet, although they were successful in some cases, have been fruitless as far as discovering the cause of the disease is concerned.

Fifteen years ago we were taught that the daily food must contain protein, fat, carbohydrate, and the ions Ca, Na, K, Mg, Cl, Fe, S, P, and I. The latter substances, with the exception of sulphur, which had to be taken in the form of cystin, could be utilized by the body as inorganic salts. We know today that there is a considerable variation in the nutritive value of different proteins. It is generally accepted, moreover, that there are certain other substances which must be present in the food if the organism is to maintain health, growth, and function. These are the so-called vitamins or accessory food substances—fat-soluble A, water-

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soluble B, and water-soluble C. It is generally conceded that the absence of these substances from the diet is the cause of certain syndromes which have received the name "deficiency diseases." Xerophthalmia results from a deficiency of the fat-soluble A, polyneuritis from a lack of water-soluble B, and scurvy appears as the result of insufficient intake of the water-soluble C. These are the so-called "deficiency diseases," and many investigators have been disposed to add others to the list—pellagra, mucous colitis, chronic intestinal indigestion, intestinal infantilism, and rickets. Rickets is not a deficiency disease in this restricted sense. It is a condition which results from faulty metabolism,—usually, but possibly not always,—caused by a faulty diet.

We have chosen the rat as an experimental animal because of its omnivorous habits, the ease with which a large colony may be maintained, its short span of life, and period of gestation and lactation. All of our experiments have been carefully controlled as regards hygiene, illumination, and exercise.

It is necessary to stop a moment here to discuss rickets as it occurs in children. In the first place, we must appreciate the fact that while the physical pathological manifestations of rickets are largely confined to the skeleton, the disease involves the whole organism. There can be no other interpretation of the loss of muscle tone, the profuse head sweats, the gastro-intestinal disorders, and the apathy or fretfulness of the rachitic child. The pathology of the bone I shall not discuss here, but the pathology of the blood is not so well recognized, and deserves attention. Howland and Kramer found that the calcium in the blood serum of the children averages 9-11 milligrams per hundred cc.; the phosphate of the serum averages 4-6 milligrams per hundred cc. Children with rickets as it is ordinarily seen show little if any reduction from the amount of calcium in the blood, but the phosphate, on the contrary, may be reduced as low as 1 milligram per 100 cc. Children may be seen with rickets, however, whose blood serum shows a marked reduction in the serum calcium, the serum phosphate remaining at or about the normal level. If the serum calcium of these children is below 5 milligrams per 100 cc., the rickets is complicated by manifest tetany. We say that latent tetany is present if actual manifestations of tetany are not found in a rachitic child with a low serum calcium. Healing of rickets is accompanied by the restoration, on the one hand, of the normal phosphate level; on the other, of the normal calcium content of the serum. Now, when rats are fed on diets of purified foodstuffs it is possible, when an uncharacterized organic substance which is contained in certain fats

is insufficiently supplied, to induce rachitic changes in the skeleton in either one of two ways. The diet may be low in phosphorus but high in calcium, or may contain an approximately normal amount of phosphorus and be low in calcium. In other words, there is a level on either side of a normal calcium-phosphate balance at which an abnormal calcium-phosphate ratio of the diet may result in rachitic changes in the bones. In the rat, then, there are two sorts of rickets, one of which results from a diet, *caeteris paribus,* low in phosphorus; one which follows the administration of a diet, *caeteris paribus,* low in calcium. It would seem as if the same thing might be true of children. Normal growth of bone depends on the maintenance of a normal ratio between the two ions,—not on the absolute amount of either in the food. The fact that a perfectly normal bone may be produced on diets which are low either in calcium or phosphorus, providing that the level of the other ion is proportionately depressed, shows that the rachitic lesion is really dependent on the ratio of calcium to phosphorus. There is an optimal level, however, for both ions, and when the balance in the diet is maintained at this point the optimal growth of the animal is assured, provided all other factors of a complete diet are sufficiently supplied. Below this point the salt content of the food may become to some extent a limiting factor as far as growth is concerned.

The optimal amount of calcium which the diet can furnish for growth, maintenance, and function in the rat has been shown to be 641 milligrams per 100 grams of ration, all other factors of the diet being satisfactory. The amount of phosphate has not been so well worked out, but it is about 493.6 milligrams per 100 grams of food. A diet containing 832 milligrams of calcium and 305 milligrams of phosphate produces a lesion which exactly corresponds to the severest form of rickets seen in children. Such an animal will have 10 milligrams of serum calcium per 100 cc., which is the same that a normal rat would show. The blood phosphate for a rachitic animal of this, the low phosphate, type, will be 2.5–3 milligrams per 100 cc.; that of a normal rat will be 8 milligrams per 100 cc. If now an animal is fed on a diet in which the calcium is reduced to 52 milligrams per 100 grams of ration, the phosphorus remaining at 364 milligrams, a lesion also results which presents all the essential characteristics of rickets. The blood of such an animal will contain ca. 4.5 milligrams of calcium and 8–9 milligrams of phosphorus.

The rôle of the fats in rickets. In May of 1921 we published an article which showed that a deficiency of fat-soluble A does not produce rickets, providing the required salt balance is maintained in the food. This has

been since confirmed by numerous investigators. A deficiency in this vitamin is followed by a cessation of growth and a condition of osteoporosis develops. There is, however, a substance present in cod-liver oil, and to some extent in butter fat, which enables an animal to compensate for a faulty calcium-phosphate ratio in the food. This substance is not the same as fat-soluble A. This uncharacterized organic substance is present, according to Zucker, in the unsaponifiable fraction of cod-liver oil. It is present in butter fat and coconut oil, as well as in cod-liver oil, but to a much less extent. Thirty per cent. of butter fat is not the equivalent of 2 per cent. of the diet in cod-liver oil, which will prevent the development of rickets on a rickets-producing diet, and in five days will usually cause visible signs of healing to appear in the bones of a rachitic rat. It will cause healing of the low calcium, as well as of low phosphate rickets. In the low phosphate form of rickets the administration of 2 per cent. of cod liver oil for fifteen days causes the phosphate in the serum to rise from 3 milligrams to 5 milligrams per 100 cc. Howland and Kramer, who have made the studies of the blood which I have quoted, have shown that exactly analogous changes occur in the blood of children under analogous conditions.

Another influence which enables the organism to compensate for unfavorable calcium-phosphate ratios is light—from the sun or the mercury vapor lamp. Huldschinsky was able to demonstrate healing in the bones of rachitic children after radiation with the mercury vapor lamp, and we have found that radiation with sunlight, the mercury vapor lamp, or the Fe-Cr, or Cd arcs, prevents the development of rickets in rats although they are maintained on diets which would cause rickets to develop without fail without the influence of radiation. Such radiation will induce healing in rachitic animals without change in the diet, and causes much the same changes to occur in the salts of the blood serum which follow cod-liver oil therapy. Radiated animals which have been treated with the light of the Cd arc under the same conditions as those which obtained in treating others with the Fe-Cr arc and the mercury vapor lamp, show more advanced healing than the other groups. Filtering the light through window glass removes the protective rays. These facts would make it seem as though the beneficial rays were of the shorter lengths of ultraviolet. From these facts it will be seen that consideration of natural illumination must in the future modify the dietary of miners, convicts, and those who from necessity or ignorance are deprived of light. Individuals who are exposed to full daylight can get on normally with the diet which in the absence of radiation would be

extremely defective. Light, though it protects against and cures rickets, has no demonstrable influence on the appearance of xerophthalmia.

The last consideration which modifies the results of a rickets-producing diet is starvation. Starvation will precipitate in three days an extraordinary degree of healing in a rachitic animal and this healing is accompanied by a marked rise in the blood phosphate. It might be supposed that this might be the result of the restoration of a normal calcium-phosphate balance when the body is left to draw its supplies of these ions from its own tissues. This is, however, not the case. The phosphate of the blood rises from the rachitic level of 3, to 12 mgs. per 100 cc., which is double the amount of the normal blood phosphate. This may be the result of tissue destruction and the release of phosphate from disintegrated muscle tissue.

To sum up, (1) rickets is a disease of metabolism usually due to faulty food. 2. It may be produced in rats by certain diets containing an improper balance between calcium and phosphorus, when an uncharacterized substance associated with certain fats is absent or deficiently supplied. 3. There are two sorts of rickets in rats, one a low calcium type, produced by diets relatively low in calcium, but containing an approximately normal amount of phosphorus, other things being equal, and second, a low phosphate type, produced by diets deficient in phosphorus, with a normal or high calcium content. 4. Some uncharacterized organic substance, which is present in abundance in cod-liver oil, enables the organism to compensate for a defective calcium-phosphate ratio in the food. 5. Exposure to sunlight or to the rays of the mercury vapor quartz lamp will do the same thing. 6. Either of these factors will induce healing in the bones of rachitic animals. 7. Starvation also will induce healing.

These investigations so far leave a great many questions still unsettled. Some of them we are in a position to answer; others await further study.

DISCUSSION OF DR. SHIPLEY'S PAPER.

Dr. R. B. Osgood, Boston: The paper this morning by our distinguished guest, Dr. Jansen, and this most interesting and extremely stimulating paper by Dr. Shipley started so many thoughts that I hardly know where to begin to comment on the work. This work that Dr. Shipley has brought out gives us some of the causes of this disturbance and shows us how treatment should be administered. As he says, the work has just begun. Starting with the

theory that there is a nutritional deficiency either in quantity or in the proper ratio of calcium intake, we must at once think of other diseases besides rickets, the etiology of which these investigations may partially solve. Possibly we still do not know whether there is such a disease as that called adolescent rickets. Dr. Freiberg says positively there is. His experiments seem to show that adolescent rickets is amenable to the same kind of treatment —I think he said cod liver oil—to which this experimental rickets is amenable. Then we have osteomalacia, a deficiency disease or a hunger disease, as the Germans suggest. This seems to be very common as a result of the war. Then we do not know how far we shall go toward solving the problem of osteitis fibrosa cystica or how far toward solving osteitis deformans or perhaps even Dr. Barrie's hemorrhagic osteomyelitis. There are suggested many problems which we shall ask Dr. Shipley to investigate in the next hundred years in connection with rickets.

I do not know how many of you have seen the book written by Mr. McCann. He recites the history of a ship's crew who all came down with what was called beriberi. A diet rich in vitamins was administered and all these so-called beriberi cases got well.

Dr. Jansen's paper is most stimulating as representing an almost philosophical approach to the problem of etiology of rickets and the bearing of heredity.

The work of Dr. Percy Howe of Boston has interested me greatly in relation to the possible infectious etiology. He has considered pyorrhoea as a deficiency disease rather than an infection. He has carried out some experimental work in which he has fed guinea-pigs a certain diet, following which they have exhibited various bone and joint disturbances which seem to resemble the changes we have associated exclusively with the infectious type. Then by simply changing the diet, the pigs become perfectly free from these joint symptoms.

All this subject is, of course, too wide for anybody to discuss. I wish to thank Prof. Jansen and Dr. Shipley most heartily for their papers.

Dr. Frank E. Peckham, Providence, R. I.: This paper is very important to the orthopaedic man. Children are being brought in increasing numbers for orthopaedic conditions which seem to be directly due to faulty metabolism. Probably it is the calcium salts which are at fault, as Dr. Shipley has brought out. In treating these cases, that certainly should be taken into account. For instance, it was only within a few days that a slightly knock-kneed and flat-footed little fellow, dragging one leg, was brought into my office. The physician who referred him to me had first referred him to a neurologist. It was simply a case where the calcium metabolism was at fault. There was the knock-knee, flat-foot, and dragging leg. The treatment of this may be mechanical to a certain degree, but it should be largely a dietetic treatment.

This study which Dr. Shipley has applied to rickets is also applicable to other deficiency diseases. There are lots of these children and they seem to be increasing in numbers, so it is brought to one's attention that something is radically wrong with the nutrition. I do not know who is to blame for it, but that element has to be taken into account. Another very important thing is that in these children the resistance to disease is lowered. I may be wrong about the statistics, but as I understand it there are about a half million children under ten years dying every year in our country because they have not the resistance to put up against the diseases which attack them. Now this lessened resistance in young life is due to some factor, and the points brought

to our attention by Dr. Shipley are of great importance. I want to thank Dr. Shipley personally.

Dr. Paul Shipley, Baltimore (closing the discussion): It may be that I have perhaps unintentionally overstated the dietary side of disease in childhood. In considering diet in relation to disease I should like to say that we have to remember that, as Dr. Jansen said to you a few minutes ago, there are many other agents which aid in the production of illness which apparently is caused and remedied by changing the diet of the child. Col. McCarrison in India has shown—and the point should be emphasized—that faulty nutrition may, by lowering the resistance of the organism to invading bacteria or to other factors of which we at present know nothing, contribute to many diseases which we are accustomed to consider of parasitic origin. It would, however, be a grave error to insist that, because the manifestations of these conditions appear coincidentally with the administration of a bad diet and are alleviated or cured by a good one, the conditions are the result of a bad diet alone. It is time that a warning should be uttered against the rising tendency to attribute disease after disease to nutritional faults. "Avitaminosis" is becoming a fad and is forming a base for the operations of quacks, nostrum venders, and misguided enthusiasts. Dr. Osgood has just now mentioned Riggs's disease as a pathology which has origin in an unfortunate dietary. While pyorrhea certainly follows the ingestion of faulty food, the diet is probably not the sole factor in the production of the disease. The resistance of the tissues, the local and general resistance, is lowered by the faulty diet, and the body is no longer able to take care of the invading organisms, which under normal circumstances it would cope with quite effectively. These organisms are allowed to carry on their work of destruction and produce an apparently inflammatory disease which in many cases is, however, remedied by restoring the diet to the optimal level and so enabling the body to realign its forces against the invading organism. There are probably other factors as well as bacteria which are allowed to work out their harm when the resistance of the organism is impaired by faulty diet. I am quite certain that the whole story of scurvy is not yet told. I am equally certain that we are not as well informed concerning beriberi as we might be. It is equally possible that there are other factors besides nutritional ones operating to produce rickets. All one can say now of rickets is that diets which are faulty in certain respects when fed to animals, are followed by the appearance of the disease. This has held through three years of careful experimental work, but as I mentioned at the beginning, we cannot tell whether these diets behave as chemical reagents, whether they act indirectly on the body as a whole, or whether they lower the resistance of the organism to some morbific agent of which at present we have no conception.

I want to thank the gentlemen who discussed this paper and the members of the American Orthopedic Association in my own name and in the name of those who have collaborated with me.

PATHOLOGY OF TUBERCULOSIS OF JOINTS. A STUDY FROM THE CLINICAL STANDPOINT.*

BY MARK H. ROGERS, M.D., BOSTON, MASS.

The present conception of the pathology of tuberculosis of a joint, if one judges from the teachings of text-books and from certain pathological studies in the literature, is, briefly, that in a large percentage of cases the original focus is in the bone, generally near or at the ephiphyseal line, and that the involvement of the joint is practically always secondary. In the decade of 1890-1900 there was evidently a great deal of controversy concerning the question of synovial and bone tuberculosis, but the tendency was toward considering the bone as the primary focus and the joint as being involved secondarily. It is not necessary to review the literature preceding this period, except to show there was a definite dispute in regard to pathology.

The conception that primary synovial tuberculosis is anything more than a rarity was evidently disputed and to a large extent discarded after the pathological work done by Nichols in 1898 was published. Nichols, working in the department of Surgical Pathology of the Harvard Medical School, studied a series of 120 cases of tuberculosis of joints, his material being obtained from operations and largely from autopsies. His paper was read before the American Orthopedic Association in 1898 and published in the Transactions of the Association, Vol. xi. This was a very careful piece of work, giving detailed description of many specimens. As a part of his conclusions he states that after an examination of 120 specimens, he is of the opinion that the primary focus is in the bone and that the involvement of the joint is a secondary process.

So that the evidence as published is distinctly that tuberculosis of the joint arises from a focus in the bone and that the joint structure is involved as a secondary infection. The pathology may be briefly described as an invasion of the bone, generally at or near the epiphyseal line, extension towards the joint surface, destruction or absorption of the joint cartilage, on account of the joint lesion underneath the cartilage, and invasion of the capsule.

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

Since that time there has been apparently little work done. Allison, in the *Archives of Surgery*, May, 1921, published a pathological study of the material from his clinic, and he also concludes that the evidence points towards a bone focus as the starting-point. He states that he agrees with Nichols.

From a clinical standpoint this conception of tuberculosis has never been absolutely satisfactory and this has led to a review of the books and references on which the conception is based. It seems to be a clinical fact that a considerable percentage of cases of tuberculosis of joints as seen at the Massachusetts General Hospital clinic could be classified as the synovial type, especially if we select those cases that are seen within the first year of the onset of the symptoms. If these same cases are examined during the third year after the onset then they are generally classified as tuberculosis affecting the bone.

Now this is a possible explanation or at least a suggestion why the pathological studies should point definitely toward a bone lesion. It is very seldom that pathological study is or can be done except on late cases. Certainly Nichols' work was done on old cases and I imagine that the operative material from Allison's clinic represented cases that were of two or three years' duration at least. There is no dispute over the accurate description of the various observers. Nichols' description of his material stands today, but his deductions and conclusions may be disputed.

The purpose of this paper is to present certain clinical evidence that tuberculosis of joints has its origin in the capsule of the joint and that the involvement of bone is usually a secondary process. The evidence to support this conception must necessarily depend on clinical studies of the early stages, because it is very rare to obtain complete material for pathological studies except in very advanced cases. After a study of Nichols' and Allison's work I am not convinced that their conclusions in regard to this one point should be accepted as absolute fact.

A few years ago it was established as a policy at the clinic to perform an arthrotomy on cases of suspected tubercular knees, especially in adults, first for diagnostic purposes, and second, to make an attempt with iodoform-oil to affect the tuberculosis. The result of this work was published by Dr. E. G. Brackett. None of these cases showed any evidence of bone involvement that could be detected by careful x-ray studies or by operative inspection. These same cases were under observation and they later developed definite bone changes and progression of symptoms which led to excision later on. These cases, then, could first

be classified as synovial tuberculosis and later on were typical examples of bony tuberculosis, and if the material were studied four years after the onset of symptoms, would, I believe, coincide with Nichols' and Allison's results.

A recent case of early tuberculosis of the hip in a young adult seems to point strongly to the invasion of the capsule as the beginning of the process. Tuberculosis of the hip beginning in adult life is rather a rare condition in this clinic and we have never seen a case that could be proved tuberculous that did not go on to destruction of bone as an end-result, or, in other words, we are not familiar with strictly synovial tuberculosis.

Mary McF., age 21, had symptoms of intermittent pain and limp of three months' duration. At times, especially after rest in bed, there was no restriction of motion, but there was slight atrophy of the thigh. At times there was limitation of internal rotation and hyper-extension by muscular spasm. The x-rays at month intervals were negative. There was a tubercular family history.

By exclusion, tuberculosis was suspected, and a tuberculin subcutaneous test gave both a temperature and local reaction. The hip-joint was explored by an anterior incision. The capsule was found thickened and reddish in color. Most of the head and neck was inspected and no evidence of any bone involvement found. A piece of capsule was excised for pathological study and showed tuberculosis. Two weeks later an arthrodesis was done, at which time the head was turned out and the cartilage removed and the acetabulum explored. No evidence of bone tuberculosis could be found in the bone.

Of course it may be said that a bone focus was overlooked, but it is rather difficult to imagine that it could be with the exposure that was necessary for a complete arthrodesis. It might possibly be synovial tuberculosis, but it is a perfectly typical story of early tuberculosis and corresponds to our findings in the knee-joint.

It seems to me that we have a good deal of evidence in regard to pathology in the careful studies of x-rays taken in early stages of tuberculosis. A study of the x-rays of the group of knee cases above mentioned shows that there was no evidence of a bone lesion, as a rule, during the first year of the disease. A slight amount of bone atrophy might be present, but this is also present in other chronic infections. Generally the first evidence of any bone involvement was a thinning of the articular cartilage and a slight irregularity of the cartilage outline, probably near the capsular attachment. Then the next step was a definite loss

of cartilage, or erosion of the surface, and only in later stages was there loss of bone substance.

I think the x-ray study of tuberculosis of the spine is a definite method of studying the progress of the pathology and we have enough accumulative evidence from studying certain cases from early symptoms to later results to draw a proper picture. Two cases are cited as examples because both were first examined early in the course of symptoms when it was not possible to make an absolute diagnosis because of lack of any deformity or x-ray evidence of disease. Both cases were adults. They were examined first over two years ago, giving symptoms of recurrent pain and stiffness in the lower lumbar spine, a region which is subject to various possibilities in diagnosis. They were carefully x-rayed at four-month intervals by very competent men, and for the first year a study of the plates failed to show any evidence of a bone lesion. During this period they were treated by fixation, and a probable diagnosis of tuberculosis was made on the history and the physical findings. They both developed abscess, one psoas and the other lumbar. In both cases over a year elapsed before it was possible to show a lesion by x-ray, long after the clinical evidence was very positive, and it took two years to show absolute bone destruction.

In studying many cases of early tuberculosis of the spine the first point noticed is the so-called narrowing of the intervertebral space. There is never any evidence of a bone lesion at first. At this stage when we cannot observe a loss of bone substance we often find evidence of a shadow that is considered to be an abscess. This means, of course, that the process is well advanced. Then later there appears loss of the articular surface, generally of two adjacent vertebrae, and a very late stage is the destruction of the body of the vertebra. I believe this holds true in children as well as in adults, except that sometimes in children the destruction or invasion of bone comes rather rapidly. But the same thing holds true that the joint space and the cartilage are involved first. If the bone were involved first, with our present ability to show complete bone structure, I believe we would have more evidence of bone lesion showing in early cases.

Now for destructive criticism. Certainly in the last decade a good many chronic conditions about a joint were called tuberculosis which have now been differentiated. Hip disease was synonymous with tuberculosis, and any bone cavity within the head or neck of the femur, whether osteomyelitis or bone cyst, was called tuberculosis. Probably many of the definite bone cavities in the lower end of the femur that

used to be considered tuberculosis have been proven to be the result of a coccus infection. If these bone lesions were mostly T. B., then it is easily understood how the present conception of its pathology has progressed and taken root.

Another point which has been suggested earlier in this paper is that most of the pathological work necessarily has been done on end-result or old cases and we all know that there may be found abscess cavities in the bone in such material. But whether it has been proved that these cavities are the original focus or the end-results of extension is not at all clear to me from reading the original papers. I rather doubt that the old contention has been proved.

I think that our best experience in studying the pathology of tuberculosis of joints has been derived from the series of cases of knee-joints, mostly adults, but some children. The same process must take place in one joint as in all joints. That is the natural supposition, so that we can study the problem in the knee, a joint which lends itself to exploratory work.

On opening these joints through the lateral internal incision, the first thing that is noted is that the true capsule is greatly thickened, reddish, and injected. This fact is always demonstrable even in the early cases and those that show absolutely no evidence of involvement of bone as far as can be judged by x-ray studies. In the early stages this may be all that can be observed on inspection of the joint. Of course all that can be seen under this incision is the capsule, the inner half of the condyle, the inner half of the articular surfaces and the upper cul-de-sac. Of course there is usually an increase of free fluid, but this is so in any infection.

The next step in the progress of the disease is the development of a reddish prolongation of the capsule, the pannus that begins to cover the inner surface of the condyle and extends over the articular surface of the femur. The gross pathology at this stage does not differ very much from that of certain other infectious processes, such as due to the gonococcus, except that tuberculosis always seems to be more spongy and reddish.

It is from this material, the capsule and the pannus, if present, that a specimen is taken for microscopic section and tuberculosis can be shown in these sections. In very early cases enough material must be used and careful and complete study must be made of the sections in order not to overlook tubercle formation. Certain reports have come back stating that there was a good deal of round-cell infiltration and

that no other diagnosis but chronic inflammatory tissue could be made, when a more careful search has revealed the definite tubercle formation.

The next step that is noticed in the gross pathology is the extension of the pannus and then the definite thinning and loss of substance of the cartilage beneath the pannus. By this time, if the loss of cartilage is of sufficient extent, it will be possible to detect the same changes in the x-ray, but it is noticeable that the destruction of cartilage is generally more extensive on inspection than appears by x-ray. Then the last stage is the loss of bone substance taking place after the loss of cartilage.

If the study of tuberculosis of the joints from the pathological standpoint is made only on the well-advanced cases, such as come from autopsy material or from late operative work, then it is conceivable how the present idea has held. Nichols' statement that all of his material showed evidence of bone lesions is correct, but of course they all necessarily showed capsular involvement, and the same is true of Allison's studies. But their conclusions drawn can be opened to discussion.

It seems that there is enough clinical evidence to prove that the primary focus is more often in the joint capsule, the same as other infectious processes; that this corresponds to the progress of the disease as studied by x-ray and by early exploratory work done for diagnostic purposes.

DISCUSSION OF DR. ROGERS' PAPER.

Dr. Nathaniel Allison, St. Louis: The paper just read by Dr. Rogers suggests to me that Dr. Rogers has tried to demonstrate by x-ray pictures and more or less by clinical findings certain facts which alone can be settled by the most careful study of pathological material. His argument is concerned with the old discussion as to "which came first, the egg or the chicken." Dr. E. H. Nichols made his report after carefully investigating pathological material. It was my privilege also to take up the study from this same point of view. Neither Dr. Nichols nor I have found any reason to suppose that primary synovial tuberculosis existed in the material which we studied. In my own case, when studying the material at my disposal, I had in mind a careful search for such evidence, but it was not forthcoming.

Dr. Rogers seems to desire to present to us the point of view that clinical observations without operation and without careful pathological study should influence in forming an opinion that there is such a thing as primary synovial tuberculosis. Speaking for Dr. Nichols and for myself, I am sure that I am safe in saying that we both feel that primary synovial tuberculosis may exist, but it is not so important to determine just what structure is the first structure involved in the invasion of a joint by tuberculosis as it is to realize that tuberculosis involving a joint area cannot be parceled out to the various structures which make up the joint. We are dealing in the vast majority of instances with bone tuberculosis—bone tuberculosis and joint tuberculosis—all one and the same picture, and not to be separately considered. It seems to me unwise, and I wish to call the attention of the Association

particularly to this point, to consider joint disease definitely as joint tuberculosis and draw deductions of a clinical nature from this before proper methods have been used to establish firmly a positive diagnosis of tuberculosis.

Dr. W. S. Baer, Baltimore: I am sure we have all been very much interested in Dr. Rogers' paper. It seems to me that the first question you have to answer is, How does tuberculosis get into the joint, into the synovial membrane, into the bone or into the joint tissues? I think Lexer has practically settled the question for us. He has pointed out perfectly well that the epiphyseal portion of the head of the bone is supplied by a series of arteries and these arteries are end arteries, that they end in and about the epiphyseal line. They are called the metaphyseal, the diaphyseal, and epiphyseal end arteries. They remain in the epiphyseal part of the bone until the child no longer needs them. Therefore, at the age of eighteen or twenty these arteries cease to exist. Therefore, in childhood we have end arteries which practically have no connection along their lines and offer a place where the tuberculous bacillus in the blood stream may lodge. This is not the case in the synovial membrane, where there are no end arteries.

So if you grant that tuberculosis is an infection which takes place by the blood stream, this will give you an explanation why tuberculosis originates in and about the epiphyseal line and not in the synovial membrane in children. I think it is possible after traumatism that the synovial membrane may be so damaged that in certain cases tuberculosis may begin in the synovial membrane. For this reason in adult cases I am quite sure that many cases are primarily synovial, although even here there is no doubt that the greater number are bony in origin. I have been doing some little work in the treatment of tuberculosis of the hip and I must confess that I think the status of the treatment of tuberculosis of the hip today is far from satisfactory. Cases of true tuberculosis under the present line of treatment do not recover quickly, nor do they recover entirely. The cases which formerly were our best cases so far as the results are concerned, have turned out to be cases of Perthes' disease and not tuberculosis. We have thought we could get good function in most of our cases of hip tuberculosis, but if you will go over your cases and study them carefully, if they are anything like mine, you will agree with me that this is far from true. I have opened a few extremely early cases of tuberculosis of the hip with the idea of doing an arthrodesis so as to make the circulation of the epiphyseal portion of the head of the bone come in direct contact with the circulation of the acetabular cavity, and thus make the blood stream continuous: in other words, do away with the end arteries. I am not ready to report upon this series of cases as yet, except to say that I am gratified at the early recession of the tubercular symptoms. If we do away with the cartilage and bring the bony surfaces directly in contact, we aid materially in eliminating the tuberculous material just as we do in a resection of the knee-joint for tuberculosis. One thing I want to say is that in the examination of pathological specimens of these early cases of tuberculosis, I found very little inflammation of the synovial membrane. The cartilage on the head was practically normal and when you stripped the cartilage from the head of the bone you found the tuberculosis between the cartilage and the epiphyseal line. If the tuberculosis had come from the synovial membrane you would certainly have had an early destruction of cartilage, but as tuberculosis is mainly an epiphyseal condition, the cartilage is not destroyed until a very late period and is the one thing that prevents an early restitution of the tissue to normalcy.

Dr. R. B. Osgood, Boston: It is stimulating that we have a few good results. One case that seems to be instructive is of a young boy, showing first in the x-ray nothing but an enlargement and squaring of the epiphyses, and a knee-joint that in the x-ray looked exactly like tuberculosis. A family history of tuberculosis and an abscess present in the popliteal space that was probably tuberculous. He was in the Children's Hospital, and later in the Massachusetts General Hospital, running a very mild course, very much like another case of Dr. Lovett's that I have seen recently. He went on for years, never showing any more than a slight erosion on one of the condyles. There was an arc of motion in the knee-joint that was entirely free from any symptoms. He could bear weight without any difficulty or pain. I allowed him to wear a brace, allowing him a few degrees less than his painless arc of motion. I followed him for three years and his symptoms subsided, with 40° to 50° of motion remaining. I then lost him. I saw him this year as a Freshman in Harvard, 18 years old. The leg on the affected side is three-fourths of an inch longer, and the x-ray shows a perfectly normal leg except for the one little area where there was the slight erosion on the femoral condyle. He is well as far as one can tell except that motion is limited to a right angle, and calf and thigh atrophy persist. Weight-bearing is painless. One cannot conceive any very large involvement of bone originally. Is it tuberculosis? I do not know, but it had all the earmarks of tuberculosis. He had an arc of painless motion, a painless abscess, and a negative Wassermann.

Dr. B. H. Whitbeck, New York City: Dr. Baer refers to the discouraging work in the treatment of tuberculosis in the conservative ways. I would like to take exception to that. We realize that in pulmonary tuberculosis recognized in the very earliest stage, if we get those patients to the Adirondacks or to Colorado, the disease is very promptly arrested and in most cases the man returns to his home with a healed process which is practically negative as far as he is concerned. If he stays at home he may die or the process may progress to the extent of destroying the lung, with cavity formation, etc. The condition, I think, is analogous to that in bone tuberculosis, and I feel that tuberculosis of the joint is a constitutional disease and at the earliest moment those children should be placed in the best possible surroundings for the cure of bone and joint tuberculosis. A number of you have been in my hospital at the seashore and have contrasted the appearance of those children with the average clinical case. It has been nothing more than good surroundings, good care, and not so much the orthopaedic treatment. I believe if these cases at the earliest possible moment when the diagnosis is made are placed in the country or at some seashore hospital, the time will come when we shall have a larger number of good functional joints. I am not prepared at present to present the results of the treatment at the hospital, but shall in the future. I believe every effort should be made to treat these cases in the same manner that the medical man treats pulmonary cases.

Dr. W. S. Baer, Baltimore: I fully agree with Dr. Whitbeck that constitutional treatment of these cases is necessary and that these patients should be treated under the best possible conditions for the cure of constitutional disease. I might say that the cases I have been treating have been in the hospital where open-air treatment is given.

The open-air treatment alone will not be sufficient. More radical procedures are necessary.

CERVICAL RIB.

(WITH A REPORT OF 6 CASES, ONE OPERATIVE.)

BY SAMUEL W. BOORSTEIN, M.D., F.A.C.S., NEW YORK CITY.

AMONG the subjects recently brought before the profession, "cervical rib" occupies quite a prominent place. We find, however, very little about it in the orthopaedic literature. In the *Journal of Orthopaedic Surgery* there are only two articles on the subject: one by Henderson,[6] the other by Plummer.[12] It seems that the neurologists and neurological surgeons claim that for their field.

The subject has, however, a great interest for the orthopaedic surgeon, as many cases of shoulder disability, no doubt, are due to cervical ribs. The diagnosis is, therefore, of importance to the orthopaedist. As for treatment—it certainly belongs to him, as bone afflictions should come automatically to him.

Within the last year, the writer has seen in his practice several cases of shoulder disability, which presented very interesting symptoms. On one patient he operated.

The fact that these cases came for complaints requiring orthopaedic skill caused him to feel that other orthopaedic surgeons are similarly consulted for such afflictions. This encouraged the writing of this article.

We will review briefly the pathogenesis and symptomatology of cervical ribs.

One must remember that vertebral changes (and one finds many of them) are frequently associated with variations in the ribs. The changes, of course, are frequent where one type of vertebra merges into the other. Thus we find cervical ribs, rudimentary thoracic ribs, and many varieties of last lumbar. The etiology of this need not be discussed at present. Henderson,[6] Honeij[7] and McWhorter[10] discuss the etiology in detail in their excellent articles.

Direct trauma, due to carrying objects such as a rifle on the shoulder, forceful motions of the arms, or even slight trauma where tension is already present, is often considered as the cause.

Gruber[7] classifies cervical ribs as follows: (1) A slight increase in the costal process, not reaching beyond the transverse process. (2) When

the rib protrudes beyond the transverse process to a certain degree and either terminates in a free end or is attached in some way to the first rib; (3) those ribs which extend well beyond the transverse process and a considerable distance towards the first rib, even reaching the cartilage of the normal first rib—they possess a good body and are often united by a ligament to the first costal cartilage; (4) the rib which is completely developed, articulating with the first costal cartilage and with the sternum.

In reality the size of the rib bears no definite relation to the intensity of the symptoms produced. Some of the large ribs have caused little or no trouble.

Many observers, especially Taylor,[17] reported that many cases present an aponeurotic band which runs forward and downward to an attachment to the first rib. This aponeurotic extension causes the same symptomatology as does a false rib of similar extent. The symptoms are more common on the right side than the left, due to greater use of that limb.

SYMPTOMS.

Honeij[7] is correct in his statement that cervical ribs present two interesting groups of cases. (1) Those that have all the symptoms associated with this condition and yet have no cervical ribs and those that give no symptoms and on examination prove to have cervical ribs. Of course, we have to add the cases that have the symptoms and do show the cervical ribs.

In the majority of cases the symptoms first appear between 20 and 30 years of age. Various reasons are given for the late appearance of symptoms; the ossification of the rib with resulting increased rigidity, which goes on between 15 and 25 years of age; traumatism, exemplified in the carrying of heavy weights in the hand or on the shoulder, which would drag the extremity downward and so increase the tension of the lower nerve roots over the false rib; habitual faulty position, standing with shoulders stooped and carried forward (Case 2), poor muscular development or marked relaxation following a debilitating illness, all of which allow the extremity to sag and increase the tension of nerve roots over rib. (Most of these causes have great significance for the orthopaedist, as he can by preventive measures guard against such occurrence.)

Keen[9] gives an excellent division of symptoms as follows:

1. Local symptoms: tumor, pain or pressure, bruit, etc.
2. Nervous symptoms more frequent than vascular.

3. Vascular symptoms: pulsations, ischaemia, gangrene, edema, thrombosis, and aneurism.

4. Muscular symptoms: wasting, loss of power, easily tired, dysphagia, scoliosis.

We will elaborate slightly on these general principles. On palpating for the tumor at the supraclavicular region one must keep in mind that the subclavian artery rises higher than normal in the neck. It passes above the rib when it is nearly or quite complete, lies in front and slightly below the tip of the less extensive ribs, or lies over the aponeurotic extension, running forward from the tip of the more rudimentary ribs.

The lung apex usually rises higher than normal. The lower roots of the plexus can be felt more distinctly than usual and are more sensitive to pressure, which also aggravates the sensory symptoms already present.

The nerve symptoms are usually neuralgic pains moving down on the same side where the rib is present. Numbness, tingling, and formication are often present. Usually the ulnar nerve or the inner cord is involved though there is no constancy about that. Some cases show analgesia. Ataxia has been described by some observers.

The vascular symptoms may vary from slight coldness to actual gangrene. Pallor, cyanosis present. Edema present. (Case 6.) A diffence in radial pulse has been reported.

Of the muscular symptoms—atrophy of certain muscles, the intrinsics of the hands, and of the thenar and hypothenar eminences are those most usually involved. There may be atrophy of the entire arm, but that is due to disuse. Loss of power in the hand grip is noted.

Rare symptoms are: hyperthyroidism and aneurism. Many observers have published cases in which dissociated sensory disturbance suggested syringomyelia. Bassoe[17] has emphasized the fact that true syringomyelia is a not infrequent associate of cervical ribs.

DIFFERENTIAL DIAGNOSIS.

We will discuss only those diseases for which the orthopaedic surgeon is liable to be consulted.

1. Arthritis.—Many cases of neuritis and shoulder disabilities are, of course, due to arthritis. One must keep in mind the muscular spasm, the limitation of motion, and frequent crepitus present in arthritis. The onset of arthritis, of course, is different. Many joints are usually involved.

2. Anterior Poliomyelitis.—Is usually in younger children and the paralysis is extensive. The pain, except at the onset, is absent. No sensory disturbance. The onset (if it occurs in an adult) is sudden. There should be no difficulty in differentiating between them.

3. Erb's Palsy.—Gives a distinct deformity of adduction and inward rotation and dates from birth.

4. Subdeltoid Bursitis.—Gives tenderness in front of the shoulder-joint just over the bursa. Limitation of motion to abduction and outward rotation. No vascular or sensory disturbance. Onset is also sudden.

5. Scoliosis of cervical region should really make one suspicious of cervical rib, as in all cases of scoliosis some abnormality of the vertebra would be present. The x-ray, of course, would show the abnormality, though both conditions may be present.

6. Callus formation from fracture of the first thoracic rib or clavicle. The history of the trauma and the absence of the neuralgic symptoms helps.

7. Occupational neuritis.—Will produce the same neuralgic symptoms, but there will be no vascular disturbance.

8. Transitory torticollis due to some nerve irritation will probably give a distinct history. No vascular disturbance.

9. Exostosis of transverse process would give the same symptoms and the treatment is really the same.

10. Tuberculosis of cervical region should not give much difficulty for orthopaedic surgeons.

11. Neuritis shows marked tenderness along the course of the nerves. The other symptoms are the same as cervical rib.

A cervical rib must be thought of in any case of sensory nerve symptoms along the distribution of the lowest brachial nerves, paralysis of the intrinsic muscles of the hand, vasomotor changes in the hand, and tumor or subclavian pulsations in the region of a cervical rib.

RADIOGRAPHIC FINDINGS.

The x-ray is of great help after a careful neurological examination. Good stereos are necessary.

One must bear in mind that normally the x-ray shows that the transverse processes of the seventh cervical vertebra are shorter than those of the first dorsal vertebra. Sometimes, however, it is difficult to decide.

Dupie and Todd[16] state emphatically that every enlargement of the transverse process of the seventh cervical is really a rib.

TREATMENT.

Radical removal should always be considered if there are no definite contraindications.

Taylor[17] gives the following guides in the prognosis following operations:

1. "The more pronounced and advanced are the symptoms, the less likely is the result to be a complete cure."

2. "The more the nerves have been damaged by the rib, the more are they susceptible to lasting damage from any traumatism at the time of operation."

3. "If operation is delayed until more or less thrombosis has occurred in the arteries of the extremity, then the result must be far from satisfactory."

4. "When a complicating neuritis involving the entire plexus is present it might well be advisable to enforce rest and treatment until the neuritis has largely subsided before removing the rib, since operation during the active stage would undoubtedly cause postoperative aggravation of the pain, and the nerves would be more susceptible to damage in other respects."

METHOD OF OPERATION.*

Operations for the removal of cervical ribs have been classified in three general groups:

1. The "anterior," in which the incision is made along the posterior border of the sterno-mastoid muscle, thus giving exposure of the front of the plexus and the cervical rib.

2. The "lateral," in which the incision is above and parallel to the clavicle, or runs along the anterior border of the trapezius muscle. In either case the exposure permits attack on the rib from the lateral aspect of the neck and plexus.

3. The "posterior," in which a vertical incision is made about 2 to 3 cm. to the side of and parallel to the spinous processes of the cervico-dorsal vertebrae, giving an approach through the trapezius muscle to the posterior aspect of the rib close to the vertebra.

* Dr. A. S. Taylor, with whom I had the privilege of working on some of these cases, and whom I assisted at the operated case, published recently a paper on the surgical aspect of the cervical rib.[17] He has been kind enough to permit me to quote him freely. The details of the operation are, except for a few personal remarks, taken *verbatim* from said article.

There are many objections to each method and some steps of these operations are quite difficult. Taylor[17] has elaborated the best method, which is more simple. The method is as follows:

The incision starts at the posterior edge of the insertion of the sterno-mastoid muscle into the clavicle and passes upward and outward to the border of the trapezius muscle, making an angle of about 45 degrees with the clavicle.

It may slant either above or below this line according to the conformation of the individual neck. This incision lies right in the natural wrinkles of the skin. After healing, it always remains as a fine hair line instead of spreading, after a few months, into a broad, ugly scar as do the skin incisions made in other directions in this part of the neck.

When this incision is carried through the skin and fascia, the transversalis colli vessels are tied and divided, the fat in front of the plexus is mobilized at its outer edge and retracted inward, and then the brachial plexus is exposed.

The cervical fascia is divided along the outer edge of the plexus, which is then separated from its bed posteriorly sufficiently to expose the rib, and is then very gently retracted forward. This rib is usually higher in the neck than one thinks it is, so that care must be exercised not to mistake the posterior end of the first true rib for it. Where the accessory rib is of good size, it is more readily identified, but when it is rudimentary it is often entirely buried in the scalenus medius muscle. In this case it is helpful to locate the prominent carotid tubercle (C VI) and then to feel just below it to identify the rib. (C VII.)

Once the rib is definitely made out, its muscular and ligamentous attachments are divided by sharp dissection so as to leave all periosteum on the rib. Great care must be used to protect the pleura and the subclavian artery.

In several reported cases, periosteum, which has been left *in situ,* has generated new bone and symptoms have recurred.

The last portions of the rib to be freed and removed are the neck and head. These are in the center of the danger zone. The seventh cervical root comes out of its spinal foramen and passes over the neck of the rib at about an angle of 60 to 70 degrees. In the rudimentary ribs the whole thing is apt to be a flat plate of bone extending from the vertebral body outward to, or a little beyond, the tip of the transverse process and having its edges in the vertical transverse plane, so that its upper edge lies just beneath the seventh root at its exit. In the more

fully developed rib, the head and neck are more like the normal and present no sharp edges to the seventh. These anatomical variations may help to explain the frequently observed clinical fact that the small rudimentary ribs often cause more neurological symptoms than do the fully developed ribs.

Just in front of the neck of the rib runs the vertebral artery with its plexus of veins, except in the unusual type where the artery enters the foramen in the seventh instead of the sixth transverse process. It is obvious then that the removal of the neck and head causes the chief hazard to the vessels and nerves.

After the outer portion of the rib has been dissected free from its attachments it is grasped by a small bone forceps and manipulated as convenience dictates while its inner portion is dissected free. Sometimes it is possible to get a clean enucleation of both neck and head, especially when they are held to the vertebra by regular articulations, but frequently, because of troublesome hemorrhage or of firm fibrous or bony union of the head to the vertebral body, one must be satisfied to leave the head of the rib *in situ*. This has seemed to cause no late disturbance. It is important to remove the rib right up to the head because there might otherwise be continuing irritation of the seventh root. This is accomplished with the slender-bladed rongeur.

During all this dissection the plexus must be held slightly forward on a blunt flat retractor with the edges rounded so as to avoid the pressure of any sharp edge on the retracted nerves. The amount of functional loss in the nerves as a result of operation is almost entirely dependent upon the skill, gentleness, and continuing thoughtfulness of the assistant holding the retractor. One must make frequent remissions in this part of the procedure with removal of the retractor to avoid the prolonged compression of the nerves.

Toward the end of the procedure, annoying hemorrhage is apt to result from injury of some of the veins forming a plexus about the vertebral artery. Packing controls this type of bleeding in a few moments. So, if by chance the vertebral artery should be damaged, it would be most unwise to attempt to clamp and ligate *in situ* because of the risk to the plexus in the necessary manipulations. However, it would be easy to expose the vertebral artery near its origin through the anterior inner portion of the wound for ligation. In the same way the inferior thyroid could be ligated if by any chance it should be injured.

In case of ribs which are complete or nearly so, the portion in front of the plexus can be dissected free and removed. The plexus can then be mobilized, gently retracted forward and slightly inward, and then the remainder of the rib removed by lateral approach to the rear of the plexus, as above described.

In the rudimentary type the entire bone may lie within the scalenus medius muscle, which must be split between its bundles until the tip of the rib is located. It is then enucleated as above described. In this type there is frequently, if not always, a strong aponeurotic extension running from the tip and lower margin of the rib forward and downward to the first true rib, or even to the sternum. This aponeurosis, being tense, causes pressure on the nerves as they pass over it. It must be thoroughly released from any attachments that hold it taut.

The rib having been removed and hemostasis secured, the fat is replaced in front of the plexus, and the wound is closed without drainage by means of interrupted and continuous silk sutures which include the skin and fascia. The lips of the wound fall together naturally. After 5 to 7 days the sutures are removed. After a short time the scar is lost among the natural skin wrinkles.

The postoperative disturbances may be due to (1) a bony new formation of the stump, especially if subperiosteal resection is done. (2) Injury to the pleura with emphysema or empyema. (3) Aneurism. (4) Injury to the plexus causing increased paralysis and muscle wasting, and (5) acute neuritis.

The nerve and blood-vessel symptoms, as a rule, gradually abate after resection of the rib, but may persist a year or even longer.

CONCLUSIONS.

1. Many cases coming to the orthopaedic surgeon with shoulder trouble may be due to cervical rib.
2. Cases presenting following symptoms: pain, especially on motion, cyanosis, and atrophy of the limb, and no limitation of motion, should make one suspicious of a cervical rib.
3. The fullness of the supraclavicular fossa, besides the x-ray, should help in the diagnosis.
4. The removal of the rib should be practiced by the orthopaedic surgeon for the same reason that he removes the transverse process of last lumbar.

5. Where symptoms have existed over a long period, and especially where paralysis and atrophy form part of the picture, removal of the rib will stop the progressive increase of the symptoms, but may not result in the entire recovery of what has already been lost. This indicates the necessity for early diagnosis, and the desirability of good stereo-radiographs of the neck in every case of persisting pain or lameness of obscure origin.

6. In all cases of shoulder trouble, x-ray of cervical spine should be taken, since, if the cervical rib may not be the sole cause, it may be a contributory cause by interference with the circulation and nerve supply.

FIG. 1.—Case 1. H. D. Showing the deformity of the spine and prominence of the scapulae.

Fig. 2.—Case 1. H. D. Anterior view, showing the fullness of the neck.

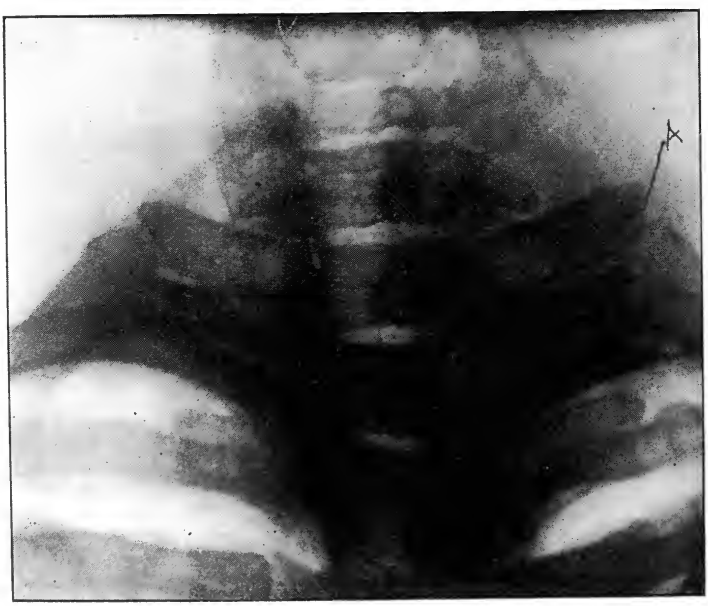

Fig. 3.—Case 1. H. D. X-ray prints of cervical spine, showing the cervical rib at A.

CASE REPORTS.

I am reporting only cases that had symptoms usually found in cervical rib. The diagnosis in every case was made before the x-ray verified the diagnosis. Cases that had cervical ribs but no symptoms, and in which the discovery was made accidentally, are not included, as they are too numerous.

Case 1.—H. D., male, age 28, came for pain and disability of left shoulder.

The history dates back to age of seven when, after some acute illness, it was noticed that the spine became deformed and that neither shoulder could be used properly. Nothing was done for that, as he lived in a small town in Russia and did not have to do a great deal of work Upon arrival in this country, he began to work as an operator and found that he could not use his shoulders well and had to give up his occupation.

Physical examination.—Patient is well developed. Angles of the scapulae are markedly prominent, giving him marked kyphosis. (Figs. 1, 2.) There is a fullness of the supraclavicular fossae, left more than right. The subclavian arteries are felt higher on both sides than in normal persons. Patient cannot abduct the arms to more than an angle of 75 degrees with torso. Rotation outward markedly limited. The fingers of both hands are extremely cyanotic and cold when hanging down, left worse than right. On raising the hands, the cyanosis slightly diminishes. The patient has absolutely no pain or sensory disturbance. Motor grip power—35 lbs in each hand. There is an atrophy of ½ inch in the right arm and forearm as compared to the left. Slight atrophy of interossei, thenar and hypothenar eminences of both hands.

X-ray shows distinct cervical ribs on each side. No arthritis present in the shoulders. (Figs. 3, 4.)

Advised operation, which patient refused.

The patient was reëxamined one year later and no change found.

Comment: This case demonstrates distinct orthopaedic disabilities as kyphosis, limitation of motion, and cyanosis, due mainly to cervical ribs. From the limitation of motion one would diagnose the case as ankylosis of shoulder-joints were it not for the interference of circulation and the fullness of the supraclavicular fossae which helped in the diagnosis. There was also absence of pain in the shoulder-joints. The cause in this case is probably some infection which caused adhesions

Fig. 4.—Case 1. H. D. X-ray prints of cervical spine at a different angle, showing the cervical rib at A.

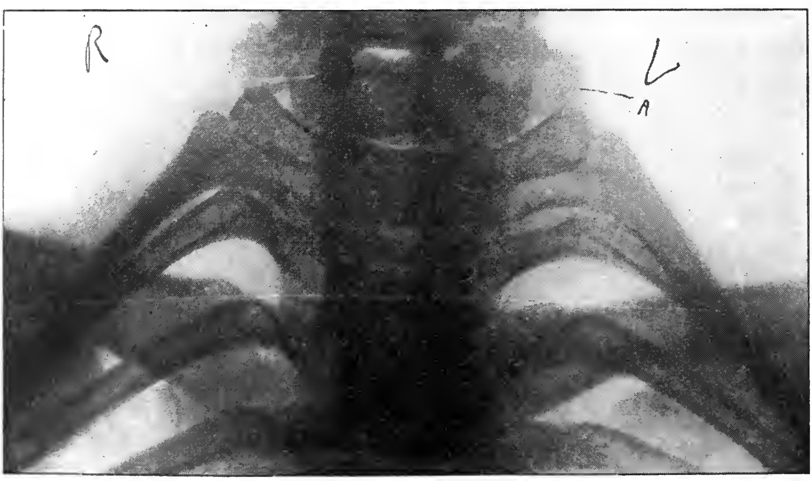

Fig. 5.—Case 2. G. J. Showing the cervical rib at A.

interfering with the motion of the shoulders. The fact that the progress is slow indicates that not all cases lead to severe vascular disturbances.

Case 2.—G. J., female, age 23. Came in November, 1920, complaining of pain in the left shoulder radiating to the fingers. History dates back one year. No cause could be ascertained.

Physical examination.—Patient is a thin-looking girl. Slight round shoulders. Marked fullness of the left supraclavicular fossa. Both scapulae are prominent posteriorly. Left shoulder presents no limitation of motion, no crepitus. There is distinct atrophy of the left arm (almost one-half inch). The left hand is cyanosed and feels cold. X-ray shows a distinct cervical rib on the left side. (Fig. 5.)

Advised operation but patient refused. She cannot be traced at present.

Comment: The symptoms here were only pain in the shoulder radiating to the fingers and slight interference with the circulation. One might easily have diagnosed it as an arthritis. The atrophy of the arm could easily be explained as due to disuse. The diagnosis was made on account of the fullness of the supraclavicular fossa and cyanosis of the fingers.

Case 3.—C. R., female, age 23. Complained of pain in the right shoulder dating back a few months. The pain was aggravated on using the shoulder in bringing it forward (flexion forward) while working. No pain at night. Pain ceased altogether after abstaining from work for a few days, but recurred with the work.

Physical examination.—Right shoulder shows distinct crepitus, especially in outward rotation. Fullness of the supraclavicular fossa. Atrophy of the arm. No cyanosis. No sensory disturbance. Before coming to me patient had seen several surgeons and diagnosis of arthritis had been made. My diagnosis was cervical rib.

X-ray showed distinctive cervical ribs on both sides, right larger than left.

Advised removal but patient refused.

January, 1922.—Sent for the patient for reëxamination and obtained the following additional notes: The pain became gradually worse so that she was finally forced to give up her work altogether. Atrophy of the hand increased.

X-ray showed that ribs have increased in size.

Comment: The characteristic pain and the fullness of the supraclavicular fossa established the diagnosis.

Case 4.—A. S., female, age 36, came to me in May, 1921.

Previous History—negative. Present Illness—dates back three weeks, with pain in the right hand and shoulder. Pain is worse at night, though she has a great deal of pain during the day. Does not complain of coldness or numbness of the fingers.

Physical—general health is rather poor. There is left facial paralysis from infancy. Right hand—fingers slightly cold and cyanosed. Right elbow—motion free, no spasm. Right shoulder—slight crepitus in outward rotation and abduction. Slight spasm in these motions. Tenderness over the deltoid bursa. Some fullness of the supraclavicular fossa. No dullness present. Right shoulder is considerably higher than the left and gives the impression of an old condition. Slight contraction of right sterno-cleido mastoid. Motor grip power—right hand, 30 lbs.; left hand, 40 lbs. No cyanosis present. Diagnosis rested between deltoid bursitis and cervical rib.

X-ray shows distinct enlargement of the transverse process of seventh cervical and suspicion of a facet. The length was about one inch more than on the left.

The patient was seen also by Dr. A. S. Taylor, who agreed with the diagnosis.

Advised removal but patient refused.

Case 5. R. E., female, age 12. Had high scoliosis since birth and had been treated with jackets, Abbott's jackets, etc., but obtained no relief. X-rays were always negative. For the last year complained of slight numbness in the left hand.

Physical.—Fullness of left supraclavicular fossa, cyanosis of the hand. Left dorsal and cervical scoliosis. X-ray showed distinct cervical rib.

Advised removal but patient refused.

Comment: The disturbance was slight, but the scoliosis was marked.

Case 6.—Max K., age 22. Physician (this case was also reported by Dr. Taylor in his paper). Came to me in June, 1920, when still a medical student.

Previous History.—Influenza in 1918.

Present Illness.—Dates back to the end of March, 1920, when he

FIG. 6.—Case 6. K. M. Showing the cervical rib on the right side.

noticed that the right upper extremity had become very much larger than the left, that it was often cyanotic, especially in the cold, and that it felt colder both subjectively and objectively than the left. The entire limb often felt very stiff. It tired very quickly under any sustained effort, but otherwise did not seem to have lost strength. Found also some discomfort in writing and excessive use. Numbness in the fingers very often. He had never had real pain. He was examined by five different specialists and diagnosis of mediastinal tumor and aneurism made.

Physical Examination.—Patient is a tall, slender man, of good color and fairly well nourished. General examination shows nothing of interest. The right upper extremity shows an increase in circumference over the left by one and one-half inches in the middle of the arm, one inch in the forearm and one-half inch in the hand. The hand is cyanosed and feels cold. Its superficial veins are twice as large as on the left side. There is distinct crepitus in the right shoulder. No sensory disturbance. Motor power grip—right, 60 lbs.; left, 40 lbs.

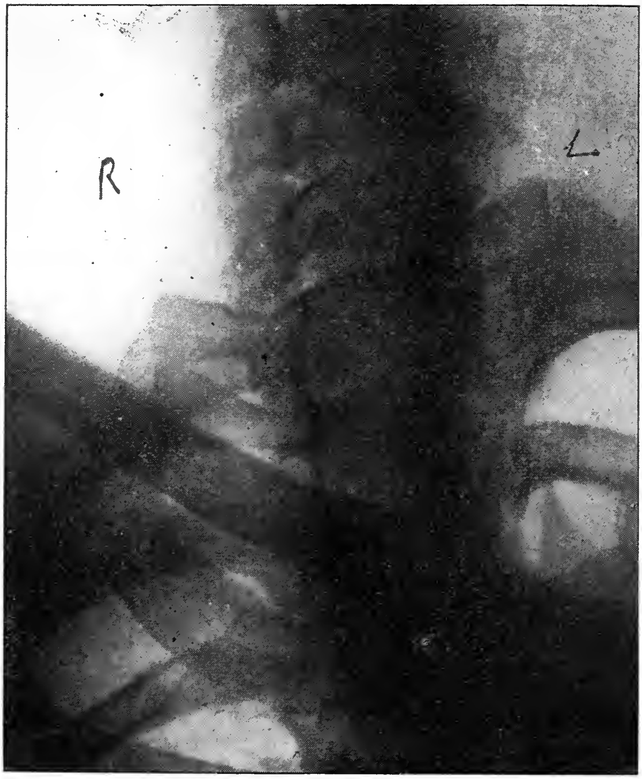

FIG. 7.—Same as Fig. 6, taken at a different angle.

In the right side of the neck there is a distinct bony prominence about on a level with the transverse process of C VII. Just below and in front of this prominence is the subclavian artery, which is well above the level of the clavicle. The cords of the plexus can be felt distinctly above it, and pressure on the lower one over the end of the prominence causes tingling in the inner fingers. There was no inequality in the radial pulses. There was no scoliosis.

The x-ray plate showed enlarged transverse process of C VII, which extended on the right side well beyond that of D I, or C VI, and was quite vertical. (Fig. 6.) As it had no facet, the roentgenologist reported that it was not a cervical rib.

I sent this patient to Dr. Byrne, the neurologist of Fordham Hospital, who agreed that the symptoms pointed toward a cervical rib, though he did not care to commit himself to the diagnosis.

The patient was then examined by Dr. A. S. Taylor, who diagnosed the case definitely as a cervical rib.

Inasmuch as the clinical diagnosis pointed obviously to cervical rib, and the transverse process of C VII was unduly large, it was decided to operate.

Operation on June 18, 1920, by Dr. A. S. Taylor and the writer.

The method described above was followed very carefully.

The rudimentary rib extended about 1-3 inch beyond the posterior tubercle of the transverse process and was a broad plate of bone which extended downward almost to the neck of the first true rib. From its tip and lower border strong fibrous bands stretched forward and downward to the first true rib.

The false rib was dissected free and then removed by rongeur, with the exception of a small portion of the head.

The C VIII and D I roots passed up over the ligamentous extension of the cervical rib, but did not appear to be under tension of pressure. The subclavian artery also did not seem to be under tension.

After the operation there was numbness of the whole extremity, with considerable loss of power, especially in the shoulder muscles. There was tingling in the fingers, especially the thumb, index, and middle fingers. Tactile sensibility was much diminished.

On the second day the congestion and cyanosis had almost disappeared and sensation and power began to return. Between the eighth and twelfth days he had several attacks of sharp pain. Aside from this his convalescence was uneventful and rapid.

Within three months the extremity became normal and has remained so.

Comment: In this case the symptoms were severe, though the rib was so small that even the radiologist refused to diagnose it as cervical rib. The result after the operation proves, however, that the aponeurotic attachment was enough to give him those symptoms.

I wish to express my sincerest thanks to Dr. A. S. Taylor for helpful suggestions.

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PAIN DUE TO ILIO-COSTAL IMPINGEMENT.*

BY F. J. GAENSLEN, M.D., MILWAUKEE, WIS.

IMPINGEMENT of the costal margin on the crest of the ilium as a cause of persistent pain, while not common, appears to occur with sufficient frequency to merit consideration. During the last five years the writer has observed five cases. I am indebted to Dr. H. C. Schumm, my associate, for notes on two other cases occurring in his hospital services. In severe cases of scoliosis it has been recognized as a not infrequent cause of pain by numerous writers, Lovett, Whitman, Tubby, Spitzy, etc. In many of these cases of scoliosis the impingement is so definite that it is evident even on casual examination, and the patients themselves may make the diagnosis for us. Pain along the costal margin as a result of impingement occurs, however, in a variety of conditions in which the impingement is not at once obvious, and unless this possibility is kept in mind, diagnosis may offer difficulties.

Since no mention has been found in the literature of its occurrence in any condition except these severe scolioses above referred to, it has seemed worth while to collect the cases observed and to report them briefly. In all the cases to be reported the pain was located definitely at the lowermost portion of the costal margin where this lies closest to the crest of the ilium. Not only was there pain at this point, but also local tenderness, and this pain and tenderness could be produced at will by pressure on the costal margin at the point indicated. In examining for this condition it is best to have the patient sitting as erect as possible, then to crowd the examining fingers under the costal margin, and finally to allow the patient to assume a relaxed sitting position, if necessary, with the trunk inclined slightly forward and to the affected side.

If impingement is the important factor, the pain which the patient complains of can be produced at will by this manoeuvre. While some discomfort is elicited on the sound side as well, it is not so acute or definite as on the affected side.

Referred pain at this point can be ruled out by the fact that the tenderness is confined to the comparatively small area of potential con-

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tact rather than along the entire length of the lower ribs. The association of tenderness localized at the point of impingement is helpful, therefore, in distinguishing pain due to impingement from referred pain due to a vertebral or costovertebral lesion or to pressure symptoms of a long transverse first lumbar process on the twelfth rib, to which Goldthwait called attention in a recent paper.

In the erect standing position the costal margin clears the crest by a safe margin of about three fingers. In the slouching attitude this clearance is considerably decreased, while in the relaxed sitting position with the normal lumbar lordosis effaced and the dorsal curve increased, the space between ribs and crest is still more reduced. That there is actually only little space in the slouching or relaxed sitting position between these bony structures is readily demonstrated, even on the normal individual, by hooking the fingers under the costal margin and inclining the trunk slightly forward and to the side, when an uncomfortable sensation of pressure is produced. It will be readily understood that slight though continued pressure may give rise to very annoying discomfort or pain.

Anatomic variations will naturally play an important rôle in the production of such symptoms, a short lumbar spine or a sacrum deeply set between the wings of the ilia will be predisposing factors, while length of ribs and degree of flare of both costal margin and iliac crest will have important bearings. In several of the cases to be reported patients were of sedentary habit, which probably contributed to the production of the impingement and the consequent pain.

In males with well-developed thorax the costal margin will override the outer margin of the crest in extreme side bending and flexion, while in the female the costal margin is more apt to descend along the median aspect of the iliac crest. Inspection of a number of cadavers in the anatomical laboratory of the University of Wisconsin showed that impingement was readily produced by side bending of only moderate grade. Contact of costal margin and crest occurred between the upper border of the crest and the distal portions of the tenth and, particularly, of the eleventh rib. In none of the bodies examined was the twelfth rib long enough to interfere.

Since the lateral and anterior portions of the abdominal wall are supplied by the lateral and anterior cutaneous branches, respectively, of the intercostal nerves, it is conceivable that referred pain may be expected in these areas. In case of pressure, therefore, on the tenth, eleventh, or twelfth intercostal nerves, pain in the lower quadrant of

the abdomen may result which might be attributed erroneously to renal calculus or to appendicitis or other intra-abdominal condition. Such an error in diagnosis had been made in one of the cases to be reported, in which an appendectomy had been done.

Rogers, in 1911, in discussing faulty posture as a cause of referred pain, reported a case in which renal calculus or appendicitis was suspected, and operation considered by another surgeon because of pain about McBurney's point. Rogers attributed the pain to irritation of the ilio-inguinal and ilio-hypogastric nerves in their course through the psoas muscle, irritation of the nerve being explained by the constant straining of this muscle in the effort to maintain body balance in spite of faulty posture. Since these nerves, ilio-inguinal and ilio-hypogastric, supply the integument about the inguinal canal rather than the integument about McBurney's point, it would seem more likely that the pain was produced by irritation of the eleventh intercostal nerve which does supply the area about McBurney's point. Irritation of this nerve could readily result from impingement of the costal margin on the ilium. At any rate, correction of the faulty posture by means of a brace which, incidentally, would also correct an existing impingement, relieved the condition entirely.

X-ray studies have not been satisfactory. In the recumbent position, with spine flattened against the table, impingement is not likely, and in the standing position, with spine flexed and inclined to the side, the mechanical difficulties of demonstrating a lack of clearance are considerable. In several of our cases a long twelfth rib was shown. X-ray evidence is, however, scarcely necessary, since the possibility of impingement is so readily demonstrated without this, even in the normal person.

Treatment should be directed to correction of the deformity or faulty posture. As a therapeutic test adhesive plaster strapping may be applied in such manner as to produce lateral flexion of the spine away from the affected side. The same purpose will be accomplished by having the patient sit on an inclined plane higher on the sound side. In wage-earners, in whom the condition is pronounced, resection of sufficient portions of the distal ends of the ribs should be performed. This is especially true in cases where conservative treatment is not practicable or is not likely to lead to permanent relief. Of the cases here reported six were operated upon, with immediate and prompt relief. In one, an aged woman with osteoarthritis of the spine, a special corset and inclined seat were advised. In none of the cases in which x-rays were taken was there evidence of pathological lesion either of ribs or crest. No macroscopic changes were observed in the portions of ribs removed.

CASE REPORTS.

1. W. R. Age 40. Complaint: Severe pain in region of right hip.

Admitted to Milwaukee County Hospital in August, 1917. On examination patient showed kyphosis of considerable degree, centering over the 3rd and 4th lumbar vertebrae, following Pott's disease of many years' standing. Some hyperaesthesia in both flanks.

Treatment: Rest in bed with traction on both head and extremities. Latter discontinued a few days later because of alleged discomfort. Tenderness confined to crest of right ilium and portion of costal margin directly opposite.

Advised: Resection of ribs.

Operation, Aug. 22nd, 1917. Discharged from hospital on Sept. 10th, 1917. Completely relieved.

In a letter dated Oct. 7th, 1920, patient states that he has had complete relief and that he is working steadily.

2. B. A. Age 52. Complaint: Pain in legs, back, and left flank.

Admitted to Columbia Hospital on Dec. 23rd, 1919. On examination pain and tenderness found to be located at left costal margin opposite highest point of crest of ilium. This pain is continuous except during recumbency; also relieved by inclining the trunk to the right.

Reënforced corset holding spine erect gives considerable relief, but patient objects to constant use of this type of corset.

Operation, Feb. 3rd, 1920. Resection of about two and one-half inches of distal ends of eleventh and twelfth ribs. Completely relieved of pain.

This patient had a laminectomy done several years previously for supposed tumor of the spinal cord. There was also a scoliosis, but this was of such slight degree that it could not be held responsible for the impingement. There was, however, an abnormal forward bend with angulation of the spine in the laminectomized area and this appeared to be largely responsible for the impingement. The pain in legs and back was due to a diffuse cord lesion.

3. R. S. Age 83. December, 1921. Complaint: Pain along lower left costal margin.

Examination shows extensive osteoarthritis of the spine with ankylosis in the moderately flexed position. Because of patient's age, reënforced corset was advised; also, inclined seat with elevation on right, in order to prevent impingement of ribs and ilium on left side.

No recent reports.

4. W. F. Age 24. Seen at Rest Haven Hospital, Waukesha, by Dr. H. C. Schumm. Complaint: Pain in right side.

In fall of 1918, after summer of strenuous hiking and carrying of

heavy pack, patient began noticing sharp pains in right side beneath ribs. At first noticed pains only after carrying a heavy pack, but gradually noticed the pain after sitting or standing any length of time in one position.

In fall of 1918 condition was diagnosed as appendicitis and patient's appendix was removed. On recovery from the operation patient noticed that old pain was still present. This pain has persisted since then, sometimes better, sometimes worse. While not severe, it has made patient quite nervous.

Examination: Stands erect when at attention, but lapses into slouching position readily. No tenderness over spine or sacro-iliac joints. No muscle spasm.

Diagnosis: Pain over tips of 11th and 12th ribs caused by impingement against crest of ilium right side. Result of faulty posture.

X-ray shows very long 11th and 12th ribs. Advised operation.

Operation on April 6th, 1921. Distal three and one-half inches of right twelfth rib was excised, also two and one-half inches of distal portion of eleventh rib. Prompt relief was obtained.

Note on May 18th, 1921: No recurrence.

5. P. N. Age 33. Complaint: Pain in left flank for past two and one-half years. Intermittent, but worse after work.

This patient had Pott's disease of seven years' duration and had a tuberculous kidney removed three years ago. Has worn a spinal brace for one year.

Examination: Showed moderate rounded kyphosis centering over eleventh and twefth vertebrae. Process probably still active. Marked tenderness along left costal margin opposite highest portion of crest.

Operation in June, 1921, distal ends of ninth, tenth, and eleventh ribs resected.

No return of pain during the past eight months.

6. J. B. Age 60. Seen by Dr. H. C. Schumm, 1922, Milwaukee County Hospital. Complaint: Agonizing and continuous pain in left flank.

This patient had Pott's disease involving the mid-dorsal region, also tuberculosis of left elbow and pulmonary tuberculosis.

The impingement was very definite and caused such extreme and continuous pain that in spite of the general condition, resection of ribs was performed by Dr. Schumm under local anaesthesia for relief of pain.

Operation was followed by complete relief of pain due to the impingement, but patient died about three or four months later of a generalized tuberculosis.

7. A. R. Age 24. Complaint: Pain in back and right flank.

Examination: Right costal margin in close contact with right crest. Etiological factors are: Osteoarthritis with ankylosis of spine in moderately flexed position and faulty posture.

Leather corset constructed which relieved pain in back to considerable extent, but pain along costal margin proved unchanged.

Operation: Resection of ribs on April 10th, 1922, with complete relief.

Patient reported on April 28th. No recurrence.

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BEEF BONE IN STABILIZING OPERATIONS OF THE SPINE.

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INTRODUCTION.

The following paper is a report of the use of an heterogeneous bone transplant, such as beef bone, in stabilizing operations of the spine. It is not a discussion of the relative merits of the different types of stabilizing operations. It confines itself entirely to the results which have been found in a series of cases which have been followed up to a period of five years after the operation.

The method followed in looking up the cases was that recommended last year by the Commission appointed by the President of the American Orthopedic Association to investigate the results of Ankylosing Operations of the Spine. The following statistics are taken from cards similar to those used by the Commission.

TYPE OF CASE.

There have been thirty-four cases operated upon in which the beef bone has been used for stabilizing purposes. All the operations have been done by members of the orthopaedic staff of the Massachusetts General Hospital, and with rare exceptions the same technique has been used.

Twenty-nine cases were diagnosed as tuberculosis of the spine; four cases, fracture of the spine, and one case, anterior poliomyelitis. In this last case the operation was done because of pain and inability to sit up from lack of enough muscle to support the lumbar spine on the sacrum.

Twenty-one patients were males and thirteen females. The four fractured spines were males, and the anterior poliomyelitis case was a female.

The ages varied from thirteen to forty-seven years. Of the tubercular cases among the males, four were in the second decade, the youngest being thirteen, the next sixteen, and two at seventeen. Six were in the third decade; five in the fourth decade and four in the fifth decade, the oldest being forty-seven. Among the females two were in the second decade, thirteen and eighteen years, respectively; seven in the third; one in the fourth, and two in the fifth, the oldest being forty-five. Of the fractured spines two were in the second decade, sixteen and seventeen years,

respectively; one in the fourth and one in the fifth, the oldest being forty-three. The anterior poliomyelitis patient was thirty-seven years old.

The occupations were as follows:

	Tuberculosis		Fractures	Anterior
	Males.	Females.		Poliomyelitis.
Automobile repair	2			
Salesman	2			
Housework		3		1
Photographer	1			
Musician	1			
Railroad	1			
School	3			
Teamster	2			
Baker	1			
Seaman	1		1	
Laborer	1			
Soldier	1		1	
Stenographer		1		
Carpenter	1			
None	1	1		
Shop		1	2	

The duration of symptoms before operation in the males with tuberculosis varied from four months, in a boy of thirteen who had an old tubercular process in the hip with a rapidly developing kyphosis in the spine, to ten years, the average being about four years. In the females with tuberculosis the duration of symptoms varied from six months to fifteen years, with an average of about three years. In the fractured spines the duration of symptoms before operation varied from two months to three and a half years. The operation seemed indicated in the latter case because of an increasing scoliosis and increasing paraplegia. The operation on the anterior poliomyelitis case was done two years after the beginning of the disease.

The occurrence of paraplegia varying in degree from weakness of the legs to complete paralysis, present either at the time of operation or with a definite history of it, was found in both the male and the female cases of tuberculosis eleven times; six times, or 28½%, in the males, five times, or 38.4%, in the females.

The occurrence of abscesses was noted under two headings: One, those which could be palpated, and the other, those seen in the x-ray. In one

case it was found that a psoas abscess which had made its way into the thigh did not show in the x-ray. In the males, abscesses were palpated in three, or 14.3%, of the cases, while by x-ray they were found in seven, or 33.3%. In the female, abscesses were present by palpation in three, or 23%, and by x-ray in ten, or 76.9%. No definite relationship could be made out between the occurrence or non-occurrence of paraplegia and abscess as to cause and effect. Abscesses occurred with and without paraplegia an equal number of times.

The disease was found in all the vertebrae from the fourth and fifth dorsal to the fifth lumbar. It was present five times at the eleventh and twelfth dorsal, and five times at the first and second lumbar, four times each at the seventh and ninth dorsal, thrice each at the eighth and twelfth dorsal, twice at the fourth and fifth lumbar, and once each at the fourth, fifth, sixth, tenth, and eleventh dorsal and second and third lumbar.

The occurrence of more than one focus of tubercular infection was noted in fourteen, or 48.2%, of all the cases: Nine, or 42.8%, of the males and five, or 38.4%, of the females. There were six cases, or 20.7%, that had two distinct foci in the spine itself, with at least one unaffected vertebra or disc between the foci. Of these, four were males and two were females. One case of a man who gave a definite history of, and still had, a discharging sinus from a tubercular peritonitis, later showed two separate foci in the spine for which a beef bone transplant was put in, is now being treated for a tubercular hip which shows in the x-ray a typical tubercular picture. Another patient, a woman, who had previously been treated for tuberculosis of the lungs, developed a focus in the spine and still later a focus in the sternum, which required an operation. A third patient, beside two definite foci in the spine, gave a history of pleurisy. There were two spinal cases which had old hip disease, both males; four cases that had had pulmonary disease, one male and three females; two males with a genito-urinary infection.

TECHNIQUE OF OPERATION.

The technique of operation is divided into three main headings, because in the treatment of tuberculosis of the spine the operative procedure is considered to be only an incident. (1) Preoperative care. (2) The operative technique. (3) Postoperative care.

PREOPERATIVE CARE.

No attempt will be made to describe the treatment of the non-operative cases even though, except for leaving out the operation itself, the treatment is in many cases the same.

The question of the diagnosis comes first. The chief point brought out by this investigation is the possibility of the occurrence in adults of more than one focus of infection in the spine. Six cases, or 20.7%, of the total number of patients operated upon showed two foci in different parts of the spine. In two of these the second focus was discovered before the operation, but in four cases it was not found first. The probable cause for missing the condition was that the x-rays did not include enough of the spine to clearly show both foci. Therefore, in adult cases especially, it is advisable to have an x-ray study both anteroposterior and lateral of the entire spine, from the sacrum to the cervical region.

The next important step after the diagnosis has been made is the preoperative care. In this series of cases it has been the custom to make use of the plaster-of-Paris bed or posterior shell. The reasons for the use of the shell are: first of all, it greatly increases the comfort of the patient. It also makes the handling of the patient, which is necessary for the proper treatment, much more simple, and lastly, by careful moulding of the shell it is possible to maintain not only some correction of the kyphos, but also, by keeping the ribs and chest in a position of expansion, to prevent the tendency to deformity that may occur in prolonged recumbency, thereby interfering with the most perfect physiology of the body which is so necessary in recovery from tuberculosis.

The posterior shell is made with the patient lying on the stomach with pillows so arranged that the lumbar spine is in a position about half-way between the extremes of its possible curves, that is, in neither full extension nor flexion. If the disease is in the lumbar region, as much correction as possible is obtained without force or pain. The shell is made so that it extends from the top of the head to just above the knees. A hole is later cut out to make possible the use of the bed pan. Special care is taken as the plaster is setting to mould the plaster into the loins at the costovertebral angle so that the ribs and the loins will be supported and the chest will thereby be kept in a position of expansion while the patient lies upon the back. This point cannot be too strongly emphasized because of its marked effect on the patient's general condition. It has been found that in those cases which have had properly fitted shells there has been less difficulty in getting them on their feet later on. The other place where careful moulding is important is at each side of the spinous processes the whole length of the cast, so that the patient lies on the erector spinae muscles or posterior angles of the ribs and thus gets no pressure on the spinous processes or the sacrum. When the posterior shell is made and thoroughly dried, the patient is placed in it and an an-

terior shell is made. If the disease is below the ninth dorsal it is not necessary to make a chin piece; if above the ninth dorsal, the chin piece is a help later on in turning the patient. It is advisable to have the anterior shell come down as far as the knees. When the two shells are made the patient is kept on the posterior shell for at least a week in order to make sure that it is comfortable and to eliminate the danger of decubitis sores. This period of recumbency also helps to relieve the congestion in the spinal muscles and thus facilitates the operation. Twice a day the anterior shell should be strapped on to the patient and the patient rolled on his face so that the back can be attended to. The anterior shell is used for the patient to lie in at the time of the operation, thereby eliminating as far as possible much of the strain that comes at such a time in the necessary moving.

PREPARATION OF THE BEEF BONE.

Gallie reported two operations done in 1915 in which he used a piece of the femur of the beef in two cases for immobilizing the spine. He points out the importance of having a cancellous portion as well as a cortical layer. Gallie also used a dog's tibia. He suggests that beef ribs split open are excellent. For this reason it was thought that the rib of the beef would be practicable. By cutting it at right angles to its flat surface it was possible to get not only two layers of cortex with a cancellous area between, but also to make use of the natural curve of the rib to fit the kyphos of the spine. It also seemed that the cortex of the rib was not nearly so dense as that of the femur and would probably allow the more easy penetration of the blood-vessels and osteoblasts into the dead bone. The strength of a rib splint depends upon the width which the splint is cut, usually one eighth of an inch, and the fact that the splint is cut from the rib in the direction of the fibres of the bone. It is surprising the strength the splint has if the force is applied in the direction of its natural curve. Laterally it has very little strength, but lateral strength is not needed necessarily in the desired fixation of the spine. (See Fig. 1).

The preparation of the rib splint is as follows: An ordinary beef rib is obtained from the butcher. This is boiled for an hour, thus making possible the easy removal of the muscles and ligaments. The splint can now be cut with an ordinary saw or a motor saw to fit the kyphos. By means of a tracing of the kyphos, accurate fitting can be accomplished. It is well to have several splints, and this is easily done, as several can be made from the same rib. The splints, so prepared, are boiled twice more

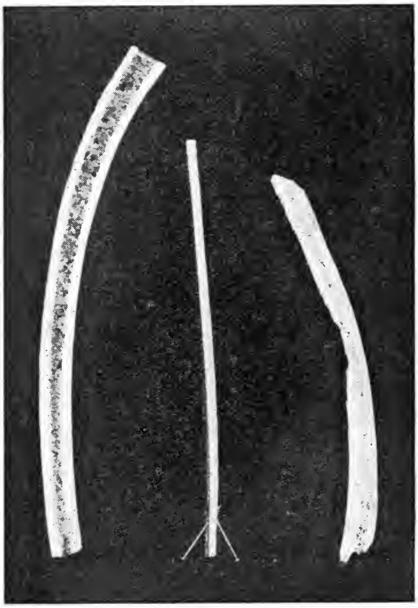

FIG. 1.—Beef Bone Splints. On left, lateral view showing two layers of cortex with marrow between. Also the amount of curve shown by the average rib. The middle figure shows the front view of a splint. The figure at the right shows a splint removed from a patient four and one-half months after it was inserted, because of sepsis.

for an hour at twenty-four hour intervals. It is necessary, therefore, to begin to prepare the splint at least three days before the time for operation.

PREPARATION OF THE PATIENT FOR THE OPERATION.

The technique of preparation used in this series of cases was to have the patient shaved and given a soap-and-water scrub with a sterile brush by a nurse who had scrubbed up as if for an operation. After ten minutes with soap and water the skin is cleaned with alcohol and this is followed with corrosive. A dry sterile dressing is put on until twenty-four hours later, when the same technique is again used. The second sterile dry dressing is not removed until the final preparation at the time of the operation the following day.

OPERATIVE TECHNIQUE.

When the operation is performed it is well to remember the points mentioned by Gallie and others: namely, accurate and perfect contact of the splint with the open cancellous surfaces of the spinous processes;

that there should not be more than three-quarters of an inch of the splint between contacts with living cancellous bone, and that each end of the splint should be buried in a spinous process.

The patient is brought to the operating room in the posterior shell and anaesthetized while still in the shell. When anaesthesia is complete the anterior shell is put on and the patient turned over. The operation is performed with the patient in the anterior shell.

The skin in this series of cases at the time of the operation was for the most part prepared with the usual iodine technique. The skin incision was carried down to the spinous processes, as little of the subcutaneous tissue being dissected as possible. The spinous processes were split with a chisel. In most of the cases a combination of the spine-splitting and the fusion operation was performed, because it was felt that by adding the fusion to the spine-splitting operation there would be more raw bone surfaces brought into contact with the bone splint. When the spinous processes were split, one-half of the spinous process was cut away from its base, and the periosteum with the spinous process attached was scraped back so that the laminae and the articular facets were exposed on one side. The laminae were then furrowed with a gouge and the bone splinters laid back into the periosteal trough so that they overlapped each other and bridged the spaces between the laminae of the adjacent vertebrae. The articular facets were curetted. The beef bone splint, which had been boiled again with the instruments, was now fitted into place as accurately as possible, care being taken not to have too great a space between the living bony contacts. The periosteum was sewed over the splint, bringing its edges as close together and as tight as possible. Special care was taken in placing the skin sutures, getting the best possible approximation. A dry dressing was applied and held in place with adhesive. The posterior shell was next applied and the patient rolled over into it upon the back and sent to bed on a Bradford frame, the latter being used simply for convenience in the nursing care.

POST-OPERATIVE CARE.

The immediate post-operative care consisted in the two-hourly shifting of the patient and the posterior shell slightly from one side to the other, until the danger of a decubitus sore had passed, which was usually in eight to twelve hours. The stitches were removed in two weeks. The patient was kept in the posterior shell for six weeks. Where possible, in the light of our experience, it would be well to prolong the period of recumbency much more than this. At the end of this time in most of the

cases of this series a plaster jacket was applied, and for the next six weeks the patient was allowed to begin gradually to sit up and to walk around. At the end of twelve weeks from the time of the operation a back brace was applied. This brace was usually made of about fourteen to sixteen gauge spring steel, thus making a support which was not of the rigid type, but did give some support by lessening the strain on the muscles of the back. The patients were advised to wear this brace for at least one year from the time they were operated upon.

POST-OPERATIVE STAGE.

An analysis of the cases in the post-operative stage gives the following results. Thirty of the thirty-four cases healed by first intention, only four of the thirty showing a slight serous discharge from the suture holes for a few days. In one case (Case 27), which had healed by first intention, the wound broke down thirty-three days after the operation and the bone splint was subsequently removed. In this case a tubercular abscess, unsuspected before operation, had been opened into at operation. Two cases (Cases 18 and 22), one from a pressure sore developing after operation and one from an abscess caused by a kidney function test breaking into the operated area, subsequently discharged their bone splints. Two other cases died from septicaemia soon after operation. One (Case 4) was undoubtedly caused by insufficient care being taken in allowing the visitors at the operation opportunity to inspect the bed prepared for the beef bone splint. The second case (Case 31) occurred in a soldier who three years previously had been filled full of shrapnel and at intervals from that time had had skin infections. This operation was done, recognizing the danger of infection, but the condition of increasing spinal deformity and paraplegia whenever he attempted to be on his feet made the operation seem advisable at the time.

The stitches in all the cases were removed on the eighth to the fifteenth day, the longer time being preferred, it being found that there was less tendency at a later date to have any spreading of the scar.

POST-OPERATIVE CLINICAL FINDINGS.

An analysis of the last reports received from the whole group, varying from one year to four and a half years, showed that nineteen were in excellent general condition; four had died as a result of the operation; four were not helped by the operation; four cases were reoperated upon, two because of fracture of the bone splints and two because the splints did not immobilize the second focus.

It was possible to examine twenty-three of the thirty-four operated cases during their post-operative period at intervals up to four and one half years. Notes on eighteen of these show that the operative area was solid and firm and there was a broad ridge of bone much wider than the normal spinous processes. In the middle of most of the spinous processes there could be felt a definite sulcus, and connecting these sulci a definite bony bridge. Three cases where the end of the bone splint was not in contact with the spinous processes showed that the end of the bone splint was freely movable and felt like cartilage.

Six cases which complained of pain a year or more after their operation, were examined and the cause of the pain was found to be not disease, but strain from postural deformities. These cases were relieved by the proper training to compensate for the deformities.

EFFECT OF OPERATION ON PARAPLEGIA.

It seems to the writer that it is impossible to state whether recovery from paraplegia, especially in the above series, was due to the operation or to the prolonged recumbency. Of the eleven tubercular cases of paraplegia, varying in degree from weakness to complete paralysis, it was possible to trace ten. Nine of these ten recovered within the course of one year. One case showed an increase of the paraplegia, which later at an operation for laminectomy was found to be due to the tubercular abscess having broken into the spinal canal and causing direct pressure on the cord. There were two recurrences of paraplegia, both due to a secondary focus in the spine not recognized at the first operation. One other patient developed paraplegia, where she had not had it before operation, after she had fractured her beef bone splint.

One case of fractured spine with complete paralysis before operation, as was expected, showed no change in the paralysis. The operation in this case was done not only to prevent the marked increase of deformity that was coming in the spine but also to prevent the associated effects on the abdominal physiology from the crowding of the abdominal organs. The infantile case showed no change except possibly some increase in the power of the glutei.

EFFECT OF OPERATION ON ABSCESS.

Of the three male cases in which an abscess was palpated before operation one reported by letter three and one half years later that the abscess had opened. This abscess was still discharging freely when seen

four and a half years after operation. Another had the abscess aspirated several times in the following two years but the abscess has now disappeared. The third was noted a year post-operative as filling up.

Of the seven male cases which showed the presence of an abscess by x-ray, four showed the abscess unchanged in the x-ray a year or more after the operation; no data could be obtained on one case, and two cases had the abscesses opened later on. One of these is the case mentioned above. Of the three female cases in which the abscess was palpated beforehand none have given any symptoms, the longest post-operative time being two and a half years, and the shortest a year. Of the ten female cases in which abscesses were found by x-ray there were no symptoms noted.

POSTOPERATIVE X-RAY FINDINGS.

An attempt was made to find out by examination of the x-rays, if new bone formation occurred and if there was evidence of fusion of the vertebrae. This proved to be very unsatisfactory because of the lack of uniformity of the x-rays as to exposure, etc., and to the variable personal equation in interpretation.

The post-operative x-ray findings were grouped under the following headings. Not every x-ray would bring out all the points noted.

(*a*) New bone formation—This would be evidenced by an increased density in the diseased vertebrae as shown in different x-rays.

(*b*) Fusion of vertebrae—as shown by the disappearance of the intervertebral discs and growth of new bone across the intervertebral space.

(*c*) Abscess—change in size; presence or lack of calcification as shown in successive x-rays.

(*d*) Beef bone splint—does it still show in anteroposterior and lateral views; change in density as compared to the spinous processes; change in size; position in relation to spine; presence or absence of fracture.

(*a*) New bone formation. It was possible to obtain post-operative x-rays in ten of the twenty-nine tubercular cases, one fractured spine, and one infantile case. These x-rays varied in length of time from four months to four years post-operative. Five tubercular cases showed definite evidence of new bone formation, and in five no change could be made out. Four males and one female showed the bony changes.

One fractured spine nearly four years post-operative showed evidence of proliferation in the spinous processes but nowhere else. The infantile case showed no evidence of new bone formation.

(*b*) Fusion of vertebrae. Of the ten tubercular cases in which it was possible to get the late results by x-ray examination, three male cases and one female showed evidence of fusion of the vertebrae. No such evidence was seen in the fractures or the infantile case.

(*c*) Abscesses. It was possible to obtain notes by x-ray of ten tubercular cases. Of these, six cases, four males and two females, showed no sign of calcification and no change in size of abscess. One female showed an increase over the marked amount of calcification she originally had. This was the case that had had her disease for fifteen years and had been completely paralyzed at two different periods. Two other women, one a year post-operative and one because of the infection due to a tubercular abscess breaking into the wound with the subsequent loss of the bone splint, followed by recumbency for two and a half years, showed some calcification of their abscesses. One male case also showed, nearly four years post-operative, slight calcification in the abscess.

(*d*) Beef bone splint. In eleven cases, five males and six females, the beef bone splint was found in the anteroposterior post-operative x-rays as long as four years after it was put in. It was found in only eight of the lateral pictures, five males and three females. This difference was due to the fact that in lateral views of the upper dorsal spine it is very difficult to demonstrate the spinous processes, as the angle of the ribs interferes.

DENSITY OF BEEF BONE SPLINT.

In eleven cases, six males, five females, including one fracture and one infantile case, the density of the spines and the beef bone splint was the same. These observations were made on plates taken from one to four years after the operation. One case taken four months post-operative showed that the spinous processes and the splint were of a different density.

CHANGE IN SIZE OF BEEF BONE SPLINT.

Eight patients, four males and four females, showed no change in size of beef bone splint. One male, a fractured spine, which showed hypertrophy of the spinous processes, showed, also, what seemed to be a slight hypertrophy of the splint itself.

POSITION OF SPLINT.

Thirteen patients, eight males and five females, showed that the splint was in place, but that in practically all the splint was nearer the tip than the base of the spinous processes. In one case, the upper extremity, and in another case the lower end of the splint was not in contact with the spinous process.

Five cases showed a break in the continuity of the beef bone splint. One patient, fifteen months, and one two and three quarters years post-operative, showed no clinical symptoms. A third patient, seventeen months post-operative, had a recurrence of pain which was probably caused by too hard work, since the symptoms disappeared with a few days' rest. It is possible that this break in continuity in the beef bone splint in the cases showing no clinical symptoms may be due to absorption of the splint. Two patients showed recurrence of their preoperative condition and were operated upon again. These cases are reported later.

TIME OF RETURNING TO WORK AFTER OPERATION.

In spite of careful instructions given to patients not to return to work for at least six to eight months after operation, it was found that one went to work eight weeks post-operative. This man felt so well that he lifted a stove and fractured his bone splint, was reoperated upon, and now has a secondary focus in his dorsal spine. Other patients varied from five months to two years before returning to work. Fourteen patients, six of whom were females and were doing housework, had returned to their original work. The remaining patients either changed their work or were not working.

DEFORMITY OF SPINE AS AFFECTED BY OPERATION.

Accurate information could not be obtained upon this point, but from what could be made out ten cases showed less deformity, six cases no change, and two cases an increase of deformity. Of the last, one was due to a fracture of the graft and the other is still under observation fifteen months after operation.

LENGTH OF TIME SUPPORT WORN AFTER OPERATION.

Eleven patients were wearing the back brace at the time the last note was made. In some of these it was four years post-operative. The braces were worn not because of pain, but because, as the patients said, they felt

less tired and safer when they had to do hard work. In these cases the support was not worn constantly. One patient (Case 11) removed his support in nine months and had no pain, but three and a half years after his operation an abscess filled up and discharged in spite of his being in excellent general condition.

FUNCTIONAL RESULT.

By functional result is meant not only what happened in the operated area but also what happened to the patient. There were twenty-four cases from which it was possible to get information from one year to four and a half years after the operation. Seventeen were in excellent general condition and were having no symptoms referable to the disease or to the condition for which they were operated upon. Two others had died of an intercurrent infection without having had any trouble with the spine after the operation. Four of the twenty-four cases came to secondary operation; two for fracture of the bone splint. In one of these the splint was not strong enough to mechanically stand the strain put upon it and in the other the patient abused his back. The other two were reoperated upon because of secondary foci not recognized at the time of the first operation. Two of these four cases are now in excellent condition. In three other cases the bone splint was removed. Of these three, one is perfectly well, one has died, and one* has been lost track of.

There were six deaths, or 17.6%, in the series of thirty-four cases. Two died immediately post-operative from septicaemia as stated above; one from miliary tuberculosis, four and a half months post-operative; one from pulmonary tuberculosis two years post-operative; one after a laminectomy for progressive paralysis one year post-operative, and one from an intercurrent infection two years after operation.

As has been stated above, four cases came to secondary operation: two because of fracture of the bone splint and two for secondary foci. These were performed from eight to eighteen months after the original operation. At these operations there was found no evidence of irritation or inflammation around the bone splint. In one case (Case 11) the cancellous portion had been replaced by connective tissue and the two cortical layers were in a fibrous tube between and through the spinous processes.

*This patient, Case 18, has recently been seen. He has been at a State sanatorium, where he was kept recumbent until the sinuses healed and then was made to get up and around without support, with the result that he is having symptoms again from the original disease.

In a second case (Case 17) there was found no attachment of the splint to the spinous processes.

In the third and fourth cases (Cases 14 and 16) the splint seemed to be attached to the spinous processes. An interesting feature was that the splint stood up like an I beam in the middle of the spinous processes and that the spinous processes were flared outward, making the ends much broader than normal. In no case was there found any evidence of the spinous processes fusing together.

Histological examinations were made of the specimens procured at the above operations and showed no evidence of new bone formation in two cases, slight evidence in one case, and in a fourth case active proliferation of bone which was apparently extending into degenerate cortical bone. These examinations were made by Dr. H. F. Hartwell of the Pathological Department of the Massachusetts General Hospital.

One of this series of cases died of miliary tuberculosis four and one half months after the operation. The spine of this patient was removed and an histological examination was made. This examination, as well as those on the experimental animals, was made by Dr. L. W. Smith of the Pathological Department of the Harvard Medical School. (See report of Case 23).

Some experimental work was done at the Surgical Pathological Laboratory of the Harvard Medical School with the help of Dr. William A. Cochrane to determine which of the three following methods gives the firmest stabilization of the spine. Two experimental dogs were used and all three types of operation were done on different parts of each animal's spine. In the dorsal region a fusion operation was done on three vertebrae according to the method of Hibbs, except that the spinous processes were cut into several thin longitudinal fragments. These fragments were placed to overlap each other. The next two spinous processes below this area were split and a fusion operation was done on the laminae and articular facets on one side only. The beef bone splint was put in so as to be in contact with the open cancellous layer of these spinous processes. Skipping the next spinous process the two processes below this were split and a beef bone splint was put in according to the method described by Albee. Immobilization for one month in a plaster jacket. (See experimental work, Cases 1 and 2).

One animal was killed fourteen weeks and the other twenty weeks after operation. Macroscopic examination of the first specimen showed that the firmest union was in the area of the fusion operation and the least firm in the spine-splitting operation. The second specimen showed

that there was no demonstrable motion in the region of the fusion or fusion plus beef bone splint. There was very free motion in the region of the spine-splitting operation.

REPORT OF CASES WHICH CAME TO SECONDARY OPERATION.

Case 11. A. DeC., age 27. Female. Diagnosis: Tubercular spine involving twelfth dorsal. Duration, two years. No paralysis, no abscess. Slight deformity. X-ray before operation showed destructive process involving twelfth dorsal and first lumbar. September 19, 1919, a beef bone splint was put in by splitting the spinous processes, no attempt at fusion being made. The patient was put back in her plaster shell after the operation and kept in it for six weeks. The wound healed by first intention, the highest post-operative temperature being on the second day, 100.8 F. The stitches were removed on the thirteenth day, the wound being clean and dry. One week later there was a slight superficial infection in some of the suture holes, but these entirely healed at the end of two weeks. Patient had practically no post-operative discomfort. At the end of six weeks a plaster jacket was applied and she was allowed to be up and around. Three months after the operation she was given a spring back brace. Eight months after the operation an x-ray showed the beef bone splint extending from the third lumbar to the ninth dorsal, a small unexpanded abscess, no new bone formation, no change in density of graft. Thirteen months post-operative patient was comfortable. K. J. normal. No abscess felt.

About one and a half years post-operative, patient had pains in her back and a recurrence of symptoms with slight paraplegia. An x-ray showed a definite fracture of the bone splint at the apex of the kyphos.

Fusion operation January 15, 1921. The beef bone splint was exposed. It was perfectly white with no sign of irritation in the tissues. A clean sequestrum. It was cracked at the second lumbar level. The outer cortex of the splint was removed. The cancellous layer had been replaced by fibrous tissue; the inner layer of cortex, like the outer, was unchanged and showed no sign of bony attachment to the spinous processes. It was in a fibrous canal and was also cracked at the same level as the outer layer. The splint above and below the site of the disease was at the tip of the spinous processes and the spinous processes themselves below the splint were solid. Part of the splint was not in contact with the lower lumbar spines. There was no sign of bone formation in the interspinous ligaments. A fusion operation was next done on both sides of the spines. The spinous processes were split in many pieces and placed to fill in all

the intervertebral gaps. Pieces of bone from the laminae were also placed to bridge the gaps.

Laboratory examination February 17, 1921: "A long slender spicule of bone showing on microscopic examination degenerate cortical bone. There is no new bone formation."

Case 16. W. T. C., age 31. Male. Diagnosis: Tubercular spine, first and second lumbar. Duration of back trouble, intermittent for ten years. Slight kyphosis, legs weak and very spastic. No abscess felt. X-ray before operation showed extensive destruction of first and second lumbar vertebrae and intervertebral disc. A large abscess shadow seen.

July 14, 1919, a beef bone splint was put in by splitting the spinous process and interspinous ligaments. No attempt was made toward fusion. The usual technique of closing the wound was followed and patient put into his posterior shell. Highest post-operative temperature 100.5 F. Stitches removed on the thirteenth day with slight sero-sanguinous discharge. Six weeks post-operative the patient's leather jacket, which he had had before operation, was applied, but it did not fit very well. At six and one-half weeks there was no unsteadiness in walking. Patient went to work, carrying tonic bottles, eight weeks after operation. A year later he lifted a stove and felt a crack in his back. X-ray showed that the bone splint extended only so that its lower extremity was in contact with one-half of the fourth lumbar spine, and there was a definite fracture of the splint just between the third and fourth lumbar spinous processes. Fourteen months after the first operation a second operation was done.

February 17, 1921: Operative exploration showed that the beef bone splint which originally had a cancellous layer between each cortical layer, was a solid piece of bone. It was white and seemed to have very small bleeding points. The splint seemed to be fused to all the spinous processes examined except to the fourth lumbar, which was below the fracture, and to the top of the third spine. The tips of the spinous processes were flared outward and the splint stood up in the middle like an I beam. The spinous processes were not fused together. A fusion operation was next done on the third, fourth, and fifth lumbar on both sides of the spinous processes; two pieces of the flared spinous process of the fourth lumbar were put in to fill in the gap between the laminae.

Laboratory examination, February 17, 1921: "An elongated bony spicule showing on examination active proliferation of bone which is apparently extending into degenerate cortical bone."*

*This case has been operated upon again since writing this paper. The operative and laboratory findings are appended.

April 29, 1922: The patient had a recurrence of the paraplegia and was running down hill. X-rays showed he had a secondary focus involving the ninth and tenth dorsal vertebrae. There was also a moderate kyphos. As this second focus was above the region immobilized by the original beef bone splint it was decided that a fusion operation should be done. This was performed after usual preoperative technique and all of the old beef bone splint was removed and sent to the laboratory for examination. The following examination was made by Dr. L. W. Smith, of the Harvard Medical School.

"Specimen consists of portions of a beef bone graft removed from a man two years after the original operation. At the time of operation complete bony union was found in this graft which had been inserted between the split spinous processes. The graft itself could still be identified, and showed no gross evidence of absorption.

"Longitudinal sections through the beef bone graft present an infiltration of the dead cortical bone by new fibrous tissue, apparently derived from the surrounding periosteum of the spinous processes. The picture is one of slow absorption of the beef bone with replacement by connective tissue rather than by any new bone formation. A few of the Haversian canals likewise show this fibrous tissue infiltration. There seems to be no definite union between the cortical bone and the surrounding tissue, except in the manner indicated. Cross sections through the tissue present essentially the same picture,—a marked response of the fibrous tissue to the presence of the foreign body, but no true stimulation to new bone formation."

Case 17. M. C., age 45. Female. Diagnosis: Tubercular spine involving eleventh dorsal. Slight kyphos. Duration, three years; had been paralyzed for two years, but had no paralysis at time of operation. Abscess felt in psoas region. X-ray showed partial destruction of eleventh dorsal with destruction of intervertebral discs between it and adjoining vertebrae.

November 6, 1919: Beef bone splint put in and a fusion operation done on the laminae and joints of one side from the eighth dorsal to the second lumbar; usual post-operative technique; stitches out on twelfth day. Wound clean and dry. Plaster jacket in six weeks and spring back brace applied four months after operation. Patient did very well for a while, but fifteen months after operation her symptoms of pain and weakness of legs had returned and further x-ray examination revealed a secondary focus between the first and second lumbar. Examination of

the previous plates showed this lesion to have been present at that time but it was not considered to be disease. Immobilization of the spine above this second focus evidently induced the activity in the second focus.

March 4, 1921: Second operation; beef bone splint exposed in its entire length. At the upper end it was not fused to the spinous processes. In the lower part it was surrounded by the spinous processes. The entire splint was intact and firm especially in the region of the disease. When it was removed there was a solid ridge of bone connecting the laminae practically the full length of the splint. Specimen of splint sent to laboratory for examination. A complete fusion was done from fourth lumbar to tenth dorsal inclusive. The spinous processes were cut in many small pieces which were placed on the laminae to overlap as much as possible. Spicules were cut off the laminae to bridge the gaps between the laminae.

Laboratory examination. 21-3-27. March 4, 1921: "Spicule of bone showing on microscopic examination degenerate cortical bone. There is a slight evidence of new bone formation."

Case 14. M. E. S., age 47. Male. Diagnosis: Tuberculosis of spine and pleurisy. Duration of disease, about seven years. Disease at eighth and ninth dorsal. Rather sharp kyphos. Some paralysis; an abscess felt. X-ray shows bodies of eighth and ninth dorsal almost completely destroyed. Bodies of eleventh and twelfth dorsal vertebrae are fused, the intervertebral disc being obliterated.

August 4, 1920: Beef bone splint put in from fifth dorsal to twelfth dorsal, fusion operation being done on the laminae and joints of one side. The usual post-operative technique. Highest post-operative temperature 101.8 on the second day. Stitches out on the eleventh day and wound clean and dry. This patient was recumbent for three months and then a jacket applied for two months. A spring back brace was applied five and a half months post-operative. Nine months after operation, after patient had been up and around for a time, there was a recurrence of his symptoms. This recurrence may have been caused by the immobilization of the upper focus of the eighth and ninth dorsal causing increased strain on the eleventh and twelfth dorsal which had been considered fused and inactive.

April 26, 1921: Spine explored by median incision from eleventh dorsal to fourth lumbar. The exogenous splint was found firmly imbedded in fibrous tissue but not attached to spinous processes of the eleventh and twelfth dorsal. The spinous processes were markedly flared

FIG. 2.—X-ray of spine removed at autopsy from a patient who died of generalized miliary tuberculosis four and one-half months after beef bone splint was put in. Note the beef bone splint in the spinous processes.

outward at their tips and the splint stood up between like an I beam. The twelfth dorsal spine was displaced posteriorly so that the laminae were considerably back of the first lumbar. Periosteum from all the exposed spines was stripped back to the articular facets, and shavings of bones from the laminae placed in the periosteal groove. The spines were splintered and overlapped as much as possible.

April 26, 1921: The laboratory examination showed "A fragment of bone showing on microscopic examination connective tissue and cortical bone, some of which is new formed. There is no evidence of tuberculosis."

REPORT OF CASE WHICH DIED AND AUTOPSY OBTAINED.

Case 23. I. M. J., age 28. Female. Colored. Diagnosis: Tuberculosis of spine and lungs. Duration of disease, one year. Vertebrae involved, sixth and seventh dorsal. Sharp kyphosis, no paralysis, no abscess. X-ray showed sixth and seventh dorsal vertebrae almost completely destroyed, also the intervertebral disc. Temperature normal.

February 25, 1921: Beef bone splint put in and a fusion operation done on one side of the spines and laminae. The usual post-operative technique was used. The convalescence was very stormy. For six weeks the afternoon temperature went to 104, from which it gradually went down to 101. At the end of four months it was nearly normal, and a cast was applied and she was able to walk. The operative wound was clean, and stitches were removed in the usual time, with no sign of infection.

Four and a quarter months after the operation the patient entered the medical ward, where she died of miliary tuberculosis. An autopsy was performed and the entire spine in the operated area was removed. Autopsy report showed tubercular ulcers of small and large intestines, tuberculosis of spine and adrenals, solitary tubercle of pons, miliary tuberculosis of lungs, liver, spleen, kidneys, etc. (See Fig. 2).

Report of histological examination of spine by Dr. L. W. Smith, Pathological Department, Harvard Medical School.

TUBERCULOSIS OF THE SPINE WITH BEEF BONE SPLINT.

First Vertebra:—The beef bone transplant is free at this level. There is considerable fibrous tissue proliferation about the graft, but at no point is it adherent or infiltrative in character.

Second Vertebra:—The bone transplant shows evidence of involvement in a tuberculous process to a very slight extent, with infiltration by the connective tissue, eating out irregularly rounded areas of bony substance. At one point a spicule of bone is firmly adherent to a mass of young connective tissue, in a center of which is a typical miliary tubercle measuring somewhat over 1 mm. in diameter.

Third and Fourth Vertebrae:—There is some suggestion of irregular channeling of one side of the bone graft with hemorrhage and connective tissue filling this area. However, it does not seem to be definitely growing into the dead cortical bone.

Fifth and Sixth Vertebrae:—The graft at this level shows close approximation of the newly formed connective tissue of periosteal origin, but does not show any definite infiltration into it.

Seventh Vertebra:—No invasion of the graft is noted at the level of the seventh vertebra.

Eighth Vertebra:—At the level of the eighth again some evidence of gouging out of the bone graft is noted, and these gouged-out areas are filled with connective tissue and occasional capillary vessels.

Ninth Vertebra:—At the level of the ninth vertebra a similar condition exists.

Dr. Smith's report was as follows: "The general impression from studies of the sections seems to suggest a gradual replacement of the bone graft by newly formed connective tissue arising from the peri- and endosteum of the vertebral tissue. It does not seem to suggest any true invasion of the cortex through the empty Haversian spaces as might be expected, and no bony replacement is noted at all in the sections. The process is apparently one of slight absorption of the dead cortical tissue and filling in of these areas by this newly formed tissue without any actual stimulating effect upon the periosteum to form true new bone . . . . The tissues are further complicated by the profuse fibrous tissue reparative action associated with the tuberculous lesions . . . One slide showed a spicule firmly adherent to a mass of young connective tissue in the center of which is a typical miliary tubercle measuring somewhat over 1 mm. in diameter."

These slides were sent to Dr. W. E. Gallie, who gave the following report:

"In looking over the slides I am impressed with the fact that the changes in the graft and along its edges are exceedingly slow. There is undoubtedly union between the graft and its bed in places, but these points of union are infrequent and they do not look strong. In many places the graft appears to be lying loose in its bed. Without a doubt the union is not nearly as solid as when unboiled bone is used. Within the compact bone there has been very little change. Here and there you can see blood-vessels, but many of the old Haversian canals are empty still. Further, there is very little evidence of absorption or replacement, except along the edges of the graft. This is in marked contrast to the appearance of an autogenous graft at four months. It is evident, therefore, that while the same changes can be expected in boiled bone when imbedded in living bone as one sees in unboiled bone, these changes are very much slower."

REPORT OF EXPERIMENTAL WORK.

These experiments were done at the Surgical Pathological Laboratory of the Harvard Medical School.

FIG. 3.—X-ray of spine of experimental animal No. 1 after removal, 14 weeks postoperative, showing three types of operation on same animal. A. Region of fusion. B. Region of fusion plus beef bone splint. C. Region where beef bone splint was inserted into the spinous processes.

CASE 1. Female dog. Medium size. Middle-aged.

Dog was anaesthetized, having had morphia. Skin shaved, and with careful asepsis, Dr. Brown, with Dr. Cochrane assisting, made an incision about the level of the shoulder blades to the crest of the ilium. The incision was carried down to the spines and in the dorsal region three spines were denuded of periosteum, and the periosteum was

scraped laterally off the laminae as far as the articular facets on both sides. With a gouge, spicules of bone were raised from the laminae and turned up and down. The articular facets were curetted, the spinous processes were then cut into several small spicules, which were detached from their base and put back so that each spicule overlapped with the next one. The next two spines below were now split longitudinally and one-half of each spine was detached from the base of the spinous process. The periosteum on this side, with its spinous process attachment, was then scraped off as far out as the articular processes. The articular facets were curetted. Thin spicules of bone were then raised from the laminae and laid in the outer edge of the wound. A previously prepared beef rib splint was approximated to the two spinous processes. The periosteum envelope with the spinous process fragment was sewed so that it was in close contact to the beef bone transplant. Skipping one spine, the next two spinous processes in a caudal direction were split and separated widely enough to allow the placing in of a segment of previously prepared beef rib. This was sewed in as the one above had been, with silk. Subcutaneous tissues carefully closed the wound, and the skin was sutured with silk. The animal was put into a plaster cast.

She made a good recovery from ether and at first seemed rather uncomfortable, but got along without much difficulty after that. The jacket was kept on for four weeks, when the itching became so severe it was necessary to remove it. The wound was clean and solid. At the end of fourteen weeks the dog was anaesthetized and killed. That part of the spine which had been operated upon was removed and saved for histological examination after photographs and an x-ray. (See Fig. 3).

Histological Examination. Case 1. "The sections through the experimental dog are unfortunately too unsatisfactory to draw any definite conclusions from. The fixation by alcohol gives such imperfect preservation of the cells that no adequate conception of any stimulative action upon the living periosteum can be detected."

Case 2. A large female dog. Operation performed October 15, 1921. Exactly the same technique was used in this animal as in Case 1. Cast was kept on about four weeks, when it was removed because of some superficial skin infection.

This animal was allowed to live for five months. During much of this time there was a discharging sinus at the upper end of the wound (the fusion end). The dog grew very fat.

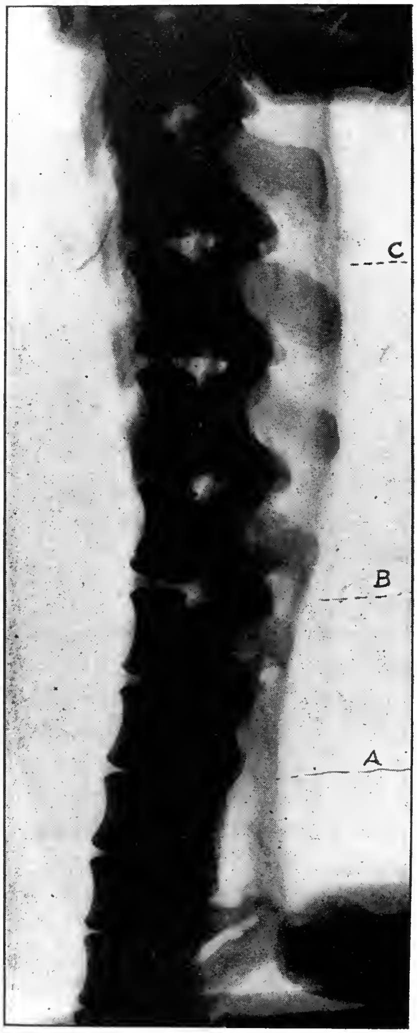

Fig. 4.—X-ray of spine of experimental animal No. 2 after removal, 20 weeks postoperative, showing three types of operation on same animal. A. Region of fusion operation. B. Region of fusion plus beef bone splint. C. Region where beef bone splint was inserted into the spinous processes. Note practically complete disappearance of the beef bone splint.

At autopsy there was found a thick layer of fat over the back. On the right side was a large subcutaneous fluctuant abscess, which discharged considerable grumous material. On the left side of the spine in the area of fusion there were found some pieces of dead bone which seemed like the spicules of the spinous processes.

On removal of the spine it was found that there was no demonstrable motion in the fusion or the fusion plus beef rib splint area. There could be felt in this latter place a thickened area resembling the beef splint. In the third region where the beef bone splint had been placed in the spinous processes there was very free motion, and a firm fibrous area resembling the beef bone splint could be felt.

X-rays taken. Specimen sent for examination. (See Fig. 4.)

Microscopically, sections through the anterior bone graft show considerable replacement of the bone by connective tissue proliferation. There is apparently union in many places between this dead cortical bone and new connective tissue which is gradually replacing it. A few areas of calcification are noted, although these do not in any way represent bone, merely discrete islands of calcium deposited between connective tissue cells. There is much more marked relationship between the graft and the new tissue in this specimen than in the one previously studied. The process in general is the same, a replacement by connective tissue rather than by true bone. In the fusion alone there is a definite union of the two bony surfaces, with islands of cartilage undergoing ossification and forming true bone in contrast to the graft area. Sections here likewise show the suture material and its gradual replacement by connective tissue. In the lower graft no bone is found, but there is dense connective tissue which has apparently replaced the bone graft. At one point in this area there is a small island of newly formed cartilage, with a suggestion of true ossification in that trabeculae are being formed and calcium deposited in them. This probably represents a small portion of the graft, and may indicate that bone formation may occur following such treatment. From these two experiments it would seem that the fusion operation in the dog gave the firmest stabilization, the fusion and the beef bone the next, and splitting the spinous processes and using a beef bone splint gave the least stabilization in one case and none in the other.

CONCLUSIONS.

1. There is no more operative risk, as shown by the immediate and late postoperative results in the above series, with the use of the beef bone splint than with any other spinal operation. In fact, theoretically,

at least, there is somewhat less risk as there is only one incision and there is not as much denuding of the periosteum.

2. The results of this series show that splints made of beef rib when put into the spinous processes are tolerated by the body at least as long as four and one-half years with no sign of irritation or inflammation and only slight signs of absorption.

3. There are certain advantages in using the beef bone splint:
   a. The saving of time at operation by having the bone splint prepared beforehand.
   b. The saving of an extra incision such as is necessary in the use of an autogenous graft.
   c. The lack of pain which may be caused by a second bone operation.
   d. The possibility of preparing the bone splint before the operation for careful, accurate fitting even when the kyphos is very sharp.
   e. The strength of the splint is great and can be determined by its width.
   f. The possibility of getting a very long splint.

4. There are certain disadvantages in the use of the beef bone splint.
   a. The beef bone being dead can act only as a scaffold and the regeneration of bone may not be as rapid as with a living bone.
   b. The fact that the dead bone is a sequestrum. The results of the above series show that if it is a sequestrum, it is not an irritative one.

5. The results found in this series of cases and the two experiments on dogs make the writer feel that immobilization of the spine is better accomplished by fusion of the laminae and articular facets than by immobilization of the spinous processes by means of a beef bone splint, with or without the fusion of the laminae and articular facets on one side of the spinous processes.

6. Finally, that in this series of cases nearly one-half had more than one focus of tubercular infection and that six of these had two foci in the spine itself.

There has been one outstanding feature brought out by this investigation and also found by the Spine Commission last year. This is the marked lack of uniformity in the method of keeping the records. If we, as an Association, ever expect to be able to get any end-results which can be trusted, we must see to it that we ourselves or our house officers not only make reliable records before operation and of the operative procedure and findings, but also of the immediate postoperative condi-

tions, and, of equal importance, accurate and intelligent notes on the subsequent conditions. We must teach our internes as well as our medical students the important points to be noted in all the above-mentioned stages so that our records will not be full of unimportant details and the important facts left unnoted. Having been working for many months on such records, I feel very strongly about this.

I would suggest that the Spine Commission make out a card which will be an improvement on the one sent out last year, so that it will be possible to have some uniformity throughout the country in the records of our spinal immobilization cases.

REPORT OF CASES.

Case 1. W. C. G. Male. Occupation: auto repairer. Diagnosis: tuberculosis of spine. Duration of disease, nine years. No paraplegia, no abscess before operation. Marked kyphosis. Left hip ankylosed by arthrodesis several years ago; probably tubercular. Disease by x-ray, seventh dorsal. Operation June 30, 1917. Beef bone splint used. Postoperative stage. Postoperative temperature first day 101.8. Convalescence uneventful. No definite effort made at fusion. X-ray report October 16, 1917: Beef bone splint is seen in the anteroposterior view from the third dorsal to the first lumbar. Seventh dorsal is diseased. No evidence of new bone formation. No fusion of vertebrae. An abscess noted in region of seventh dorsal. No calcification of the abscess. No change in density of splint. The splint is in place. June 4, 1920, patient in excellent condition. No pain in region of operation. No sign of psoas abscess. For some weeks has had pain in the low back when tired. Is still wearing his brace. April, 1921: By letter patient says he went to work seven months after operation at his old job. He now has no pain, no abscess, no weakness, and is still wearing his brace part time.

Case 2. H. N. N. Male. Occupation: salesman. Diagnosis: tuberculosis of spine. Duration, two years. For eleven months slight paraplegia. Psoas abscess felt. X-ray examination before operation shows disease of first and second lumbar. Operation, September 26, 1917. Beef bone splint from eleventh dorsal to fifth lumbar. Postoperative stage. Postoperative temperature 100.5. Convalescence uneventful. Six weeks after operation abscess noted as being smaller and softer. March 25, 1922: Patient went back to his old work as a salesman ten months after operation. He wore his plaster for eleven months and the leather jacket for nine months more. Three and one-half years

after operation, after an attack of influenza, the psoas abscess began to discharge in the left groin. He had another attack of "flu" this year and when seen had been in bed for several weeks because of high evening temperature, which was considered by the physician an attack of influenza. During the past year he has not been able to work much because of pain in the stomach and getting tired. The back has not bothered him. Because of the symptoms he had gone back to the leather jacket. Up to a year ago he had gained thirty-two pounds. Examination shows patient looks very well. The operative wound is solid and firm. There is a sulcus felt in each spinous process and a bridge of bone can be felt in the interspinous spaces. Patient moves around freely in bed. There is a slight suggestion of a prominence of the tenth dorsal which is above the old operative area, suggesting the possibility of a second focus. No motion can be made out in the region of the operation.

Case 3. A. J. D. Male. Age 25. No occupation. Diagnosis: tuberculosis of spine and lungs. Duration of disease, ten months. No paralysis. No abscess. X-ray shows disease of fourth lumbar. General symptoms before operation, severe attacks of vomiting. Operation May 3, 1918. Beef bone splint and fusion on one-half of laminae from tenth dorsal to first lumbar. Postoperative stage. Postoperative temperature 100.5, which continued throughout his stay at the hospital. After the operation he had vomiting attacks similar to those some months previous to operation. No infection of wound. December 10, 1919, twenty months postoperative x-ray shows the bone splint still present. It is the same consistency as the spinous processes and shows no sign of the cancellous portion of the beef bone splint. It has not increased in size. Six months after operation the psoas abscess was noted as filling up. March 25, 1920, patient was in very bad condition. Vomiting had returned. Examination showed involvement of the right apex. He was sent to the State Sanitarium, where he died later.

Case 4. L. M. Diagnosis: tuberculosis of fifth lumbar. Died; septicaemia, postoperative.

Case 5. C. V. Female. Age 24. Occupation: home. Diagnosis: tuberculosis of spine. Duration of disease, six months. Complete paraplegia for four months. No abscess. X-ray showed extensive destruction of fourth and fifth dorsal. Operation April 15, 1918. Beef bone splint and fusion from the second to the seventh dorsal. Postoperative stage, uneventful except for some drawing up of the legs. May 10, 1920: For one year after operation patient recovered from paraplegia so that

she could walk without assistance. When seen in 1920, patient was seven months pregnant. Examination at this time showed a complete bony bridge in the region of the operation. No motion could be made out. Some protective muscle spasm. X-ray was unsatisfactory except that it showed abscess formation in the region of the dorsal vertebrae.

Case 6. M. R. Male. Age 28. Diagnosis: tuberculosis of spine. Occupation: photographer. Duration of disease, one year, nine months. No paralysis; no abscess. Considerable kyphosis. X-ray showed tuberculosis of ninth and tenth dorsal and intervertebral discs. Operation, October 26, 1917: Beef bone splint and fusion. Postoperative stage uneventful. Highest postoperative temperature 100.2 the first day. May 10, 1918, reports that back gives him no pain. Is not sensitive to jar. He feels stronger, is beginning to go without brace. May 12, 1921, patient reports by letter. He went back to his original work eight months after the operation. No abscess and no weakness of the legs. Two years after operation he had some severe pain, but does not complain of it now.

Case 7. J. A. W. Male. Age 31. Occupation: musician. Diagnosis: tuberculosis of spine, tubercular peritonitis, tuberculosis of hip. Duration, six to nine years. No paralysis. Psoas abscess on right. X-ray shows tuberculosis of twelfth dorsal and first lumbar and ninth and tenth dorsal, with narrowing of intervertebral spaces. December 21, 1917: Ten-inch beef bone splint with fusion on one side of the laminae. Post-operative stage. Highest temperature first day 100.2. Convalescence uneventful. Eight months later psoas abscess had increased so much it had to be aspirated several times. February 20, 1922: Two years after operation while patient was working, having had no difficulty with his back, but still slight discharge from the old peritoneal infection, began to have severe pain in the right hip, which showed on x-ray definite signs of tuberculosis. He has been in a plaster cast for two years and is now in very good condition. Has no paralysis, no paraplegia. The psoas abscess can no longer be felt. There are no symptoms in the spine. Examination of the spine shows solid bony union with a bridge of bone the entire length of the operative region. X-ray February 20, 1922, shows evidence of disease between the ninth and tenth dorsal and twelfth dorsal and first lumbar. No evidence of abscess. The beef bone splint is still evident in both the anteroposterior and lateral views. The splint seems to be the same density as the spinous processes. Splint is in place, except possibly in the upper part.

Case 8. C. R. F. Male. Age 28. Occupation: railroad. Diagnosis: tuberculosis. Duration of disease, seven months. No paraplegia. No abscess. X-ray shows extensive destruction of twelfth dorsal with involvement of eleventh dorsal and first lumbar. Operation June 5, 1918. Beef bone splint with fusion from eighth dorsal to third lumbar. Postoperative stage. Highest postoperative temperature 101, second day. Convalescence otherwise uneventful. February 3, 1920, x-ray shows an old tuberculosis of spine with marked proliferative changes. No definite shadow of bone splint made out. May 9, 1921: Said he went to work thirteen to fourteen weeks after operation. The operation relieved the pain and made his back feel stronger. He has had no abscess. He was glad he had the operation. Seen by the Spine Commission, which said, "ankylosis—good result." February 20, 1922, reports he is feeling fine and never thinks of his back. Examination shows that the patient handles himself freely. No motion can be felt in the spine in the region of the scar. A definite sulcus can be felt in the spinous process and a bony bridge can be felt between them. The spinous processes in the operative area are close together and are enlarged to one and one-half times their normal width. February 20, 1922, x-ray shows that the eleventh and twelfth dorsal and first lumbar seem fused. There is marked new bone formation and the abscess is calicified. The bone splint is not seen in the anteroposterior picture, but is seen in the lateral, and has the same density as the spinous processes. It has not increased in size. It is placed well down in the spinous process.

Case 9. R. J. B. Age 40. Female. Diagnosis: tuberculosis of spine. Duration of disease, fifteen years. Complete paralysis with recovery later at two different intervals, the first time for fourteen months, and three years later for two years and seven months. Partial paraplegia at time of operation. No abscess could be felt. X-ray showed marked destruction of three dorsal vertebrae with abscess formation and calcification of abscess. Operation June 14, 1918. Beef bone splint. No attempt at fusion. Convalescence uneventful. X-ray December 16, 1919, showed much abscess formation and calcification. X-ray June 16, 1920, showed marked calcification of old abscess, marked destruction of sixth to ninth dorsal vertebrae. No definite evidence of beef bone splint. June 16, 1920, seen by the Spine Commission, which said there was ankylosis and good result. February 20, 1922, patient feels very well, better than for years. Can walk a good deal, but tends to get tired. Is doing her housework. She has no pain due to the old disease. The deformity she thinks is less than before the operation. No abscess

can be felt. There is no sign of paraplegia. She wears the brace occasionally, depending on the work she is doing. Is very glad the operation was done. Examination of the spine shows it is firm and solid in the operative region, with no tenderness. A sulcus can be felt in the spinous process and the bone splint can be felt in the interspinous spaces. Knee jerks not exaggerated. No clonus. X-ray February 20, 1922. Disease at the seventh, eighth, and ninth dorsal. Very large abscess with extreme amount of calcification. The beef bone splint can be seen in the anteroposterior view. The density of the splint is the same as of the spinous processes and can be seen extending from the fifth to the eleventh dorsal.

Case 10. T. T. Age 17. Male. Occupation: none. Diagnosis: tuberculosis of spine. Duration of disease, two years. No paraplegia; no abscess. X-ray shows disease of the fourth lumbar. Operation June 23, 1919: Beef bone splint and fusion. Postoperative stage. Highest postoperative temperature second day 101.2. Convalescence uneventful. February 7, 1922, general health very good. Has been working six months as a waiter. No abscess can be felt, no paraplegia. Bony bridge can be felt in the operative area. The operative area feels like a broad, heavy ridge of bone. Lateral motion suggests mobility at the level of the third lumbar. X-ray at this date shows the bone splint from the first lumbar to the first sacral. There is loss of continuity of splint between the second and third lumbar. There is no sign of fusion of the splint to the spinous processes. Density of splint the same as of the spines. The vertebrae give definite evidence of calcification, particularly near the narrowed intervertebral disc. No sign of abscess.

Case 11. A. DeC. Age 27. Female. Diagnosis: tuberculosis of spine. Case reported above under heading, "Report of Cases which Came to Secondary Operation."

Case 12. L. J. C. Age 13. Male. Occupation: none. Diagnosis: tuberculosis of spine and hip. Duration: tuberculosis of hip nine years; spine four months. No paralysis, no abscess. X-ray July 25, 1920. Complete obliteration of hip-joint. Extensive destruction of head and acetabulum. Almost complete destruction of eleventh and twelfth dorsal vertebrae. Operation October 22, 1920. Beef bone splint. No attempt at fusion. Convalescence uneventful. Highest postoperative temperature second day, 102. A plaster jacket applied in twenty-eight days. Sent home for further recumbency for two months postoperative. February 11, 1922, patient feels fine, but if he sits down long his back

gets tired and there is some soreness in the right loin. He has no pain referable to the old disease. The deformity was somewhat lessened by the operation, according to the patient's word. No abscess can be felt, no sign of paraplegia. Examination shows that the upper portion of the splint is free and can be moved above the spinous process. The rest of the splint can be felt as a firm bridge of bone from the eighth dorsal to the third lumbar. There is some spasm of the lumbar muscles. February 11, 1922, x-ray shows the disease at the eleventh and twelfth dorsal vertebrae, which are practically absent, with slight involvement of the tenth. There is definite evidence of calcification of the bones and there seems to be fusion between the two destroyed vertebrae and one-half of the tenth. An abscess is present in the x-ray, but shows no calcification. The beef bone splint can be seen in the anteroposterior and lateral views. There is definite lack of continuity in the splint at the apex of the kyphos. The splint is not in contact with the second and third lumbar and with only a small part of the first lumbar spine. The splint touches the seventh dorsal spine, but there is a space between it and the spinous process. There is no sign of fusion of the splint to any of the spines. The ninth and tenth spinous processes overlap the splint but do not seem to be fused with it.

Case 13. E. N. Age 13. Female. Occupation: school. Diagnosis: tuberculosis of spine. Duration, one and one-half years. Marked kyphosis, complete paralysis for two months before operation in spite of being on frame. No abscess felt. X-ray shows extensive destruction of ninth and tenth dorsal and the disc between them, with the abscess around them. Operation December 27, 1920. Beef bone splint with fusion. The splint was broken and made to overlap in order to fit the kyphos. Nine spinous processes were operated on. Convalescence uneventful. Highest postoperative temperature on the first day, 101.2. February 11, 1922: Note from the doctor says child is working around the house; general condition is excellent. She has no pain, no abscess, and she has entirely recovered from the paralysis.

Case 14. M. E. S. Age 47. Male. No occupation. Diagnosis: tuberculosis of spine, eighth and ninth dorsal, eleventh and twelfth dorsal; tuberculosis of lungs. Case reported above under "Secondary Operation."

Case 15. A. DeS. Age 33. Female. Occupation: shop. Diagnosis: tuberculosis of spine. Duration of disease, two years. Slight paraplegia seven months before operation. Abscess felt on the right side. X-ray before operation shows tenth and eleventh dorsal abnormal in

shape with obliteration of the intervertebral discs. Space between the twelfth dorsal and first lumbar also appears abnormal. Operation September 25, 1919. Beef bone splint, no fusion. Five spinous processes operated upon. Plaster shell for six weeks, jacket for six weeks more. Highest postoperative temperature 100.5. Stitches out in eight days, wound dry. Three days later, considerable discharge of blood clot. Wound dry at end of five and one-half weeks. At the end of six weeks patient was able to walk with good balance. September 26, 1921: Patient wore the brace for a year after the operation. She has had no pain in the back, but is beginning to feel very weak again. X-ray shows the beef splint present, but that it stops directly at the second lumbar and does not support the questionable pathology in this region.

Case 16. W. T. C. Age 31. Male. No occupation. Diagnosis: tuberculosis of spine. Case reported under "Secondary Operation."

Case 17. M. E. C. Age 45. Female. Occupation: home. Diagnosis: tuberculosis of spine. Case reported under "Secondary Operation."

Case 18. E. S. Age 26. Male. Occupation: baker. Diagnosis: tuberculosis of spine. Two foci. Duration of disease, seven months. Some paraplegia before operation. X-ray shows disease at eleventh and twelfth dorsal and partial destruction of the third lumbar with definite evidence of abscess. Operation December 28, 1920. Two beef bone splints overlapping each other were used to take in both foci. No fusion. Spines from the eighth dorsal to the sacrum operated upon. Highest postoperative temperature 100.3. A pressure sore developed in the back due to improper postoperative care, and both beef bone splints were removed fifteen days after operation. It has been impossible to get the end-result in this case.

Case 19. J. W. Age 47. Male. Occupation: pilot. Diagnosis: tuberculosis of spine. Duration, nine months. Some paraplegia. No abscess felt before operation. X-ray shows destructive process of seventh and eighth dorsal with involvement of the intervertebral disc. Operation May 5, 1919. Beef bone splint with fusion from fourth to eleventh dorsal. Posterior shell in six weeks. Plaster jacket. Highest postoperative temperature 100 on the second day. After twenty days a small amount of serum expressed from the wound. There was no inflammatory action. There was some pus found in the urine for two weeks after the operation. Patient returned to Nova Scotia and was not seen again, but a note dated March 27, 1922, said, "Patient is looking splendidly well and fit, and doing his work regularly as a pilot."

Case 20. G. DiC. Age 40. Male. Occupation: laborer. Diagnosis: tuberculosis of spine, tubercular epididymitis coming on seven months after operation. Duration, seven months. No paralysis, no abscess. X-ray shows narrowing of the intervertebral disc between the first and second lumbar with slight irregularity of the body of the second lumbar. Operation January 22, 1921. Beef bone splint and fusion. Very wide gap between spinous processes bridged by a section of the spinous process. Operation from the tenth dorsal to fifth lumbar. Plaster shell for six weeks, then plaster jacket six weeks, then a brace. Convalescence uneventful. December 7, 1921: Spine in the region of the graft is completely immobilized. He has no symptoms. Has been working three months. Is still wearing the brace.

Case 21. R. Z. Age 18. Female. No occupation. Diagnosis: tuberculosis of spine. Duration of disease, one and one-half years. No paralysis before operation, and large fluctuant abscess could be felt. X-ray before operation shows destructive process of fourth and slightly of the fifth lumbar. Operation November 16, 1920. Beef bone splint, and no fusion, from the third lumbar to the second sacral. Plaster shell for three weeks, then plaster cast and short back brace applied at the end of five months. Convalescence uneventful. February 4, 1922: Is doing lots of work around the house. She gets tired very easily and has pain in the side the same as before the operation. There has been no increase in the deformity. There is a psoas abscess, but it is not as large as before operation. No paraplegia. The operative region shows definite motion in the middle of the operative area. A definite sulcus can be felt in the spinous process. X-ray December 9, 1921, shows extensive destruction involving fourth and fifth lumbar and the disc. No positive evidence of the bone splint in this region.

Case 22. H. S. M. Age 37. Male. Occupation: salesman. Diagnosis: tuberculosis of kidney; tuberculosis of spine. Duration of disease, one year and nine months. Slight paraplegia for three weeks. No abscess felt. X-ray September 8, 1920, showed an abscess with involvement of the fifth and sixth dorsal vertebrae. Operation December 30, 1920. Beef bone splint. No fusion. From second dorsal to seventh dorsal. Very stormy convalescence. Second day temperature to 103. On the sixth day large abscess found in the wound with discharge of pus, which gave on culture streptococcus. This abscess seemed to come from the region of the shoulder, where a kidney function test had been done a few days before the operation. From this time on, the patient was

recumbent in the plaster shell, but continued to get worse. Paraplegia became very marked, so that he had extreme jumping spasms. He died December, 1921, after a laminectomy to relieve the progressive spasticity. Operation showed tubercular abscess in the spinal canal, pressing on the cord.

Case 23. I. M. J. Age 28. Female. Colored. Occupation: home. Diagnosis: tuberculosis of spine; acute pulmonary tuberculosis. Duration of disease, one year. No paralysis, no abscess, no temperature before operation. X-ray shows complete destruction of sixth and seventh dorsal and intervertebral discs. Operation February 25, 1921. Beef bone splint and fusion. Very stormy convalescence, temperature rising to 104 every night for six weeks. Patient died of miliary tuberculosis. Case reported under histological findings.

Case 24. J. E. G. Age 25. Male. Occupation: soldier. Diagnosis: tuberculosis of spine. Duration of disease, indefinite. No paralysis before operation. Question of an abscess felt in the right iliac fossa. Operation April 28, 1920. Beef bone splint and fusion on one-half of the laminae from the eleventh dorsal to fourth lumbar. Plaster shell for six weeks, cast for six weeks more, and then a brace. Convalescence uneventful. November, 1921: patient is feeling fine. The operative region is solid and firm. Has been given postural exercises because of some pain in the low back region.

Case 25. G. H. Age 25. Female. Occupation: home. Diagnosis: tuberculosis of spine. Duration four years. No paraplegia, no abscess felt. Condition at this time very acute, with extreme pain. December 22, 1920: Wedge-shape vertebra, seventh dorsal, with small abscess around it. Operation January 3, 1921. Beef bone splint with fusion of one-half the vertebra, nine spines being operated upon. Recumbency for twelve weeks and plaster jacket for thirteen months. Convalescence uneventful except for slight serous discharge. No infection in wound. February 1, 1922: Disease at seventh dorsal, inner border of the sixth and eighth are impinging, and there is slight destruction of the lower border of the sixth. The edges of the bone show some increase in density. There is no fusion of the body and the abscess can be seen and there is some increased density in this. The bone splint is present in the anteroposterior and the lateral views. There is no attempt at fusion in the diseased area. The splint is in place. Examination

shows the operative area is solid and firm and no tenderness. Patient complains of pain in the region of the ribs and of getting tired easily, although otherwise in excellent general condition. She is to be kept recumbent six months more.

Case 27. W. G. Age 27. Female. Occupation: stenographer. Diagnosis: tuberculosis of lungs, tuberculosis of spine, tuberculosis of sternum. Duration of disease, one year. No paralysis, no abscess. X-ray before operation shows disease about tenth and eleventh dorsal with abscess. Operation October, 1917. Beef bone splint with fusion. An abscess was opened into at the time of operation which discharged tubercular pus through wound. The wound was clean and dry after operation, but on the thirty-third day it broke down, discharging tubercular pus. Beef bone splint was eventually removed. She was recumbent two and one-half years because of the spine and the tubercular sternum which later developed. February, 1922, patient is very well, working every day. Complains of no pain and the tubercular sinuses have all healed.

Case 28. A. R. Age 22. Female. Occupation: shop. Diagnosis: tuberculosis of spine and lungs. Duration of disease one year. No paralysis, no abscess. X-ray before the operation showed destruction of cartilage between the tenth and eleventh dorsal with abscess formation. Operation August 23, 1917. Beef bone splint and no fusion. Eighth dorsal to second lumbar. Convalescence uneventful. Highest postoperative temperature 100. Patient was lost track of, but died about two years after operation from intercurrent infection. Was practically well as far as the back was concerned.

Case 29. N. H. Age 39. Male. Occupation: carpenter. Diagnosis: tuberculosis of spine. Duration, one year. Sharp kyphos. No paralysis, no abscess felt. X-ray before operation shows eighth dorsal nearly destroyed. There is a question of involvement of the ninth, tenth, eleventh, and twelfth dorsal, which was considered to be healed. A large abscess can be seen at the eighth dorsal. February 5, 1920: Beef bone splint with fusion of one-half the laminae from sixth dorsal to first lumbar. Posterior shell for six weeks, jacket for nine weeks more, then a spring back brace. February 4, 1922, patient went to work as a carpenter three months after operation. Is still wearing his brace and is in excellent general condition. Has put on lots of weight. Has no pain and he thinks his back is straighter. Examination shows the

bridge of bone nearly an inch wide the entire length of the operative area. No motion can be made out. Considerable spasm of the lumbar muscles in the ordinary standing position, but no limitation of motion here. X-ray report February 4, 1922: The condition of bones practically the same as x-ray before operation, showing same amount of involvement. There is no definite evidence of new bone formation. The same evidence of fusion is present in the ninth, tenth, eleventh, and twelfth dorsal. The abscess is present with no sign of calcification. The bone splint cannot be made out because of interference by the ribs and sternum.

CASE 30. H. H. F. Age 16. Male. Occupation: seaman. Diagnosis: fractured spine. Duration, eight weeks. No paraplegia. Some weakness in legs. Operation May 1, 1918. Beef bone splint and fusion of one-half of the laminae from eighth dorsal to third lumbar. Convalescence uneventful. X-ray examination December 11, 1918. First lumbar vertebra was wedge-shaped. February 3, 1922: Patient has been working for two years. He never has any trouble with pain in his back. Two years ago he had some lameness in the low back below operation. Was given postural exercises which he has been doing regularly. There is no sign of paraplegia, no abscess, abdomen is negative. He is extraordinarily well-muscled and holds himself in good posture. Examination shows a broad bridge of bone an inch and one-quarter wide over the entire operative area. No tenderness or motion made out. At the lower end the splint is not in contact with the spinous process and it feels a little like cartilage at this point. X-ray February 4, 1920: Twelfth dorsal shows a slight compression. The bone splint is in place between the spines of the eleventh and twelfth dorsal. There has been a loss of continuity of the splint. The splint is slightly less dense in places than the spinous processes. There is no evidence of fusion of the vertebrae. No new bone formation in the spine. February 10, 1922: The x-ray shows the bone splint is still present. It shows definite fusion to the spines of the tenth, eleventh, and twelfth dorsal and first lumbar, and partial fusion between the second and third. The density of the splint is the same as the spinous processes. There seems to be bony overgrowth all along the region of the splint. The spinous processes of the eleventh and twelfth and first seem to be fused, and it is difficult to make out the bone splint. The splint looks as if it had been replaced by new bone.

CASE 31. F. G. L. Age 30. Male. Occupation: soldier. Diagnosis:

old fracture, scoliosis, increasing paraplegia, superficial shrapnel wounds. Duration of disease, three and three-quarters years. No abscess. No definite paraplegia, but increasing weakness. Very marked deformity. X-ray before operation showed an extensive destruction of three lower dorsal and first lumbar. Operation January 22, 1920. Very long beef bone splint with fusion on the right side. Ten spinous processes operated upon. Splint was eleven inches long. Patient died on the eighteenth day postoperative from severe scpticaemia, evidently caused by a multiple skin infection.

Case 32. J. M. Age 43. Male. Occupation: shoemaker. Diagnosis: fracture of the spine. Duration, four months. No paralysis, no abscess. X-ray before operation shows fracture of the ninth dorsal. Operation February 20, 1920. Beef bone splint and fusion of one-half of the laminae. Seven spines from the fifth to the twelfth dorsal operated upon. Posterior shell six weeks, plaster jacket. Highest postoperative temperature 100.8 on the second day. Convalescence uneventful. It has been impossible to follow this case.

Case 33. A. S. Age 17. Male. No occupation. Diagnosis: Fractured spine. Complete paraplegia, increasing deformity. Duration of disease one and one-half years. Complete paraplegia, no abscess. A laminectomy had been performed some time shortly after the accident. X-ray before operation shows marked deformity of the bodies of last three dorsal and first lumbar. January 28, 1918: Beef bone splint. The conditions found at operation were unusual because of the laminectomy previously performed. Some of the articular processes were fused but there were two places where there was no fusion. These were fused and a beef bone splint put in to bridge the gap. February 22, 1922, a letter says there has been no change in the boy's condition as regards the paralysis. He said he was all right from the knees up and complained of no pain in the abdomen such as he had before the operation.

Case 34. M. C. Age 37. Female. Occupation: home. Diagnosis: infantile paralysis. Duration, two years. Complete paralysis from the waist down. Complaint: inability to wear a brace, and marked pain in the lumbo-sacral region. December 8, 1917: The beef bone splint with fusion was done from the third lumbar to the third sacral vertebra. The highest postoperative temperature was 100 the first day. Convalescence uneventful. About a year later an arthrodesis according to the Smith-Petersen method was done on the sacroiliac joint. February 25, 1919: X-ray shows the splint in place extending from sacrum

to third lumbar spinous process. It is in contact with the spinous processes, but shows no evidence of fusion with them. The splint is of the same density as the surrounding bone. February 14, 1922: The bone splint is still present, but is not as definitely seen as two years ago. The two cortical layers seem a trifle broader and the cancellous layer somewhat less broad than at previous note. That part of the splint between the third and fourth lumbar spine is seen with difficulty. Final examination February 14, 1922, shows patient in excellent condition. There is a broad ridge of bone extending from sacrum to the third lumbar. Patient can sit up without her jacket, but wears the leather jacket most of the time, having little or no pain in the back. There has been a very definite return of muscle power in both gluteal muscles.

DISCUSSION OF DR. BROWN'S PAPER.

Dr. Fred H. Albee, New York: I am very sorry Dr. Brown did not include the autogenous graft in his experimental work, especially since the purpose of his paper was apparently to prove the relative value of the living autogenous graft, the boiled bone splint, and the fusion operation of Hibbs. Boiled bone acts as a foreign body in its tolerance to the tissues. In Dr. Brown's series of 24 cases, to my mind, the fact that three of the boiled bone splints came out is proof that it is much less tolerant than the living autogenous graft. It is a foreign body; it is not living tissue. Back in 1910, at the Cornell Animal Hospital, I did a considerable number of these experiments and published a few of them. Operations to immobilize the dog's spine with living bone taken from the same dog, from sheep, from rabbits, and with boiled bone were done. The findings were quite striking between, for instance, the heterogeneous graft taken from the sheep and that taken from the dog, the autogenous graft. We found that where there was no infection, the autogenous graft could be healed in a very short period, a week or two weeks, by primary union. There would be primary union of the soft parts to the graft precisely as we get a primary healing of a soft wound. It was quite different with the heterogeneous graft or sheep's graft, which always lay in a pocket of serum. There was a liquefying action set up by contact of heterogeneous tissues. There was no primary union of the graft to the soft parts. The same condition occurred when boiled bone was used. Dead bone lowers the resistance of the tissues to infection precisely as does any foreign body. Certainly the dangers from putting in foreign bodies are greater as far as infection goes than a living graft.

Now as to the disadvantages of the boiled bone splint. Of course, boiled bone was used a number of years ago, some ten or fifteen years, by the Germans. There is quite a little literature giving experiences with it; in fact, in the first book I wrote upon bone grafting I enumerated the German table of the relative values placed upon the various internal splints. I have had this experience many times in which we would have the end of the living autogenous graft laid bare by sloughing of the skin with only a corner of the graft sequestrating. I am sure that many of you who have done bone grafting know that if you have a mild infection the infection may remain at the end of the graft where it occurs in the way of a stitch abscess and never

disturb the main portion of it. If you are using a foreign body, such as ivory or boiled bone, infection occurring at one end will always travel to the other end of the splint and it must all come out. I remember one graft which I put in for non-union of the olecranon becoming entirely bare by slough of the soft parts, much to my surprise at the time, ten years ago, it healed so completely and an excellent result obtained. Though it may stay in for six months or a year or longer, it is always a devitalizing influence to the host tissues surrounding it, and there is always danger of infection occurring about it because of *locus minoris resistentia.* I would like to mention in passing a modification of my technic of implanting a graft for Pott's disease, which I borrowed from Forbes, and he, perhaps, in turn borrowed from Hibbs, of turning down bone shavings from the upper and inferior surfaces of the spinous processes so that we have the effect of the bone tibial graft besides the internal immobilization and additional osteogenetic foci of the bone shavings.

Now to take up Dr. Brown's objections to the autogenous graft: First, he says there is the saving of time in the operation if boiled bone is used instead of the living autogenous graft. How much time do you save in the operation? In favorable cases I am sure that I can demonstrate to anyone who comes to my clinic the ability to do this operation in twenty minutes. How much of that time is consumed in taking out the graft? Perhaps five minutes. Next, the saving of an extra incision. I do not see that saving of that extra incision is any advantage. We find that the two incisions heal as quickly as one. Third, lack of pain in the second incision. That is certainly of no moment and I am sure will be borne out by men who have done bone graft work. Fourth, the possibility of preparing the bone splint before operation and the time thus saved at the operating table. Of course, the time of preparation of the graft at operation is so short that it is of no moment. In regard to strength of the graft, if one cuts the graft so that the greatest cross-section comes at the fulcrum of the graft one gets a very strong splint. Of course, it is very necessary and obvious that the fulcrum point of the graft, its central portion, should come at the crest of the tibia. Then the question of the possibility of getting a sufficiently long splint. If this operation is done when it ought to be, there is no trouble about getting a sufficiently long tibial graft. In the cases which Dr. Brown showed where he put in those tremendously long splints involving four healthy vertebrae on either side of the diseased ones, I believe it not only unnecessary but unwise to put in such a long splint.

Now as to the beneficial influence of recumbency: If there is any value in recumbency in the treatment of hemiplegia complicating Pott's disease, we get the same effect to a greater degree in ankylosis of the involved portion of the spine.

THE PATHOLOGY OF OSTEITIS DEFORMANS, PAGET'S DISEASE.

BY SYDNEY M. CONE, A.B., M.D., F.A.C.S., BALTIMORE.

[From the Pathological Laboratory of the University of Maryland.]

Osteitis deformans as a disease entity was first described by Sir James Paget, under the title "On a Form of Chronic Inflammation of Bones (Osteitis Deformans)", in the *Medical Chirurgical Transactions* (London), Volume lx, 1896, page 37. Since then many typical cases have been described and the original photographs published. Much has been written of atypical cases, such as Paget's disease of single bones, Paget's disease involving only the face bones, and Paget's disease involving the small bones (phalanges of fingers). The disease has been related to osteomalacia, senile rickets, neurotrophic bone lesions, fibrous osteitis, leontiasis ossea, acromegaly, pulmonary osteoarthropathy, syphilis inherited or acquired, senile osteoporosis, bone hypertrophy, hyperostosis in elephantiasis and from other causes, traumatism, osteomyelitis, hydrocephalus, chronic rheumatism, and arthritis deformans. Some have suggested its relation to an infectious process, whether typhoid, syphilis, malaria, or influenza. Few have studied the bones and fewer have studied the bones, organs, and tissues.

It has been my good fortune to study the bones, tissues, and organs of a case which has already been perfectly written up clinically and published. The case is the first of six described by Hurwitz in the *Johns Hopkins Bulletin* (Volume xxiv, No. 261, page 263, September, 1913). The patient, J. P., age 85, had been attended by Dr. Lockard of the University of Maryland at various times since 1905. He admitted the patient to his clinic in August, 1920, complaining of frequent micturition with burning and stinging, and hematuria. Patient also had protruding hemorrhoids. He had enlarged skull, kyphosis, contracted chest, flaring of upper pelvic brim, bowed femora and tibia, rough, nodular, curved clavicles and radii,—a typical picture of Paget's osteitis deformans. He died December 1, 1920, when an autopsy was performed by Dr. Maldeis. Unfortunately neither the pituitary gland nor skull bones could be obtained.

The protocol of the autopsy has been kindly given me by Professor Hugh Spencer, to whom I am most thankful. To Dr. William Carson I am much indebted for taking the photographs and making lantern slides of the pathological specimens.

Name: J. P.

Location: Ward H, No. 21.

Date of admission: August 22, 1920.

Date of death: December 1, 1920.

Autopsy performed: December 1, 1920.

Clinical diagnosis: Paget's disease.

Body is that of a very much emaciated white male. Rigor mortis and post-mortem lividity present.

Head: Enlarged.

Eyes: Pupils are contracted, but equal.

Nose and ears: Normal.

Mouth: Both upper and lower set of teeth missing.

Neck: No glandular enlargement.

Chest: Clavicles are both thickened and deformed, more marked on the right side. Chest is flattened in its lateral diameter, bulging in the lower portion, somewhat elongated. Axillary glands not palpable.

Abdomen: Is flattened.

Left radius: Is bent considerably; bowing of the tibiae. Surface veins are prominent all over body. Inguinal glands are palpable. Very small amount of subcutaneous fat, and poorly developed muscles. Kyphosis of the upper dorsal vertebrae.

Peritoneal cavity: No free fluid; no evidence of inflammation. General gastro-enteroptosis. Transverse colon is below the umbilicus. Liver is 9 cm. below the ensiform cartilage. Gall-bladder is distended. Vessels of the omentum are engorged. Appendix is short, firm to the touch, and tortuous; no adhesions, postcaecal in direction. Bladder is slightly distended. Diaphragm in normal position.

Thoracic cavity: Is free of fluid on both sides. Adhesions on both sides, more marked on the left. The heart is normal in position. Lungs on both sides are retracted from midline, exposing the whole of the pericardial surface. Pericardial sac contains about 40 c.c. of blood-tinged fluid. Heart lies free. The heart, thoracic and abdominal aorta with branches were removed *en masse.*

Heart: Is firm to the touch; the vessels at the base are very thick

and firm. The right auricle shows nothing of interest. Right ventricle—Endocardium is shining and glistening everywhere. Tricuspid and pulmonary valves show nothing of interest. Left auricle shows nothing of interest. Left ventricle—There are a few post-mortem clots; chordae tendinae are hypertrophied and shortened. Mitral valve is thickened along its free edge and contains lime deposits. Aortic valve—Leaflets are irregular, shortened, and somewhat thickened; contains lime deposits. Both coronaries are tortuous and show sclerotic changes and lime deposits; lumen still patent. Musculature of the heart is light red in color and shows an increase in connective tissue.

Aorta: The ascending arch is somewhat dilated, not abnormally so. The wall of the arch is atheromatous and there is an area of softness and a marked prominence on the posterior wall which is covered over with a bloody material showing organization. This area was observed only after stripping the pulmonary vessels from the aorta; it was apparently well enclosed. The entire aorta shows atheromatous degeneration in various stages of development; the lower portion, including the branches, shows marked advanced arteriosclerosis.

Right Lung: Adhesions on the right side are extensive, practically obliterating the cavity, and they can be broken up only with some difficulty. It is air-containing throughout, being less so in the lower lobe. The pleura is thick and dull. Bronchi and divisions show a moderate amount of bloody fluid. Pulmonary vessels show nothing of interest.

On section the apex shows an old, healed, encapsulated tubercle; the rest of this lobe and middle lobe is of a light red color, and blood-tinged, frothy fluid scrapes off. The lower lobe is dark red, drips blood, and there are a few well-defined, light-colored, granular, partly consolidated areas. The border of the lung is emphysematous.

Left Lung: The pleura has a few fairly well organized tags. It is air-containing throughout, but less so at the base. The hilic structures and sections show the same changes as the right, with the exception that there are no tubercles present.

Larynx and trachea and other mediastinal structures show nothing of interest. The glands are hypertrophied, firm to the touch, anthracotic in appearance.

Liver: Weight 350 grams. The wall of the gall-bladder is thin, bile is ropy and thick and black, and there are a few small stones present. The ducts are patent. The liver cuts with little resistance; the central

vessels of the lobules are slightly engorged; periphery is increased and whitish in appearance.

Spleen: Weight 130 grams. Capsule is very much thickened. On section there is a marked increase in connective tissue elements. The organ is very firm, dark red in color; corpuscles stand out plainly.

Kidneys: Together weigh 364 grams. Both kidneys show the same changes. The capsule strips with difficulty, leaving a granular, slightly pitted, red surface containing a small cyst. The cortex is very irregular in outline, striations cannot be made out. Glomeruli are indistinct. Medulla is irregular, pyramids are not well defined, and there is slight congestion in this area. Pelvis contains an excess of fat; otherwise negative. Ureters show nothing of interest.

Bladder: Contains a stone the size of an English walnut, and there is a papillomatous growth at the base; the mucosa is markedly congested and very angry looking, and covered with a mucous material. The ureteral orifices are patent and show considerable inflammation about them.

Prostate: Is slightly hypertrophied and shows an increase in connective tissue elements.

Suprarenals: Are firm and show fibrous changes at the cortex.

Oesophagus: Shows nothing of interest.

Stomach and Duodenum: Stomach shows a congested mucosa and petechial hemorrhages; is rather small. Duodenum shows nothing of interest.

Pancreas: Lobulations well marked; slight congestion, and there is a stone in the pancreatic duct. Marked sclerosis of the pancreatic vessels.

Small and large intestines show nothing of interest.

Anatomical Diagnosis: Osteitis deformans (Paget's disease). Generalized arteriosclerosis in all stages of development. Arch of the aorta shows an ulcerated type with an overlying blood clot.

Lungs: Bilateral chronic pleurisy; oedema and congestion, and patches of bronchial pneumonia at the bases.

Heart: Chronic changes in the mitral and aortic valves, with lime deposits; sclerosis of both coronaries; fibrosis of the myocardium. Nuclei enlarged and budding. Brown pigmentation. Vessels arteriosclerotic.

Liver: Chronic passive congestion.

Spleen: Chronic passive congestion. Hyaline degeneration of vessel walls and trabeculae.

Kidneys: Chronic interstitial nephritis and arteriosclerotic changes; congestion and hemorrhage into the tubules.

Bladder: Acute cystitis with stone and tumor mass, the size of a marble, on a pedicle.

Prostate: Interstitial hypertrophy.

Suprarenals: Chronic changes. Arteriosclerosis; calcification of media; muscle and veins hyperplastic.

Stomach: Congestion and petechial hemorrhages.

Pancreas: Chronic changes and stone in the pancreatic duct.

Enlargement of the bony skeleton, with irregularities in the shape.

Heart: Hypertrophied and fibrous.

Aorta: Arteriosclerosis.

Lungs: Oedema; congestion; broncho-pneumonia; chronic pleurisy.

Liver: Chronic passive congestion.

Pancreas: Chronic changes.

Suprarenals: Chronic changes.

Spleen: Passive congestion; chronic splenitis.

Prostate: Chronic interstitial hyperplasia.

Kidneys: Chronic parenchymatous nephritis.

The bones removed for pathological examination are: vertebra, rib, clavicle, radius, tibia.

The tibia is 45 cm. long and 4.5 cm. in diameter. It is bowed forward and there is a projection backward of its head of about 1.5 cm. Its surface is smooth. The periosteum strips readily, not tearing bone with it; periosteum not thickened. No nodules seen, but bone is not perfectly smooth.

Section shows a thickening of the cortical portion of the tibia. The cortex at the middle of the bone measures 2.5 cm. at its anterior portion; the posterior portion measures 1.5 cm. Its cortical thickening is dense bone, irregular in its formation toward the medulla, where it projects in parts, particularly at the middle of the bone, into the marrow cavity. Here, at one point, there is no marrow cavity left. The marrow is yellow, fatty, and contains spongy trabeculae throughout its extent. It is congested at the middle of the bone where the cortical bone is thickest. At this point there is a thinning of the bone on the concave side of the tibia to ¼ inch, and it is jagged and irregular at the marrow substance. Here and there in the dense bone are seen

widened canals surrounded by deep brown pigmentation. At the posterior projecting portion of the head four intercommunicating empty cysts are seen in the medulla, ½ cm. to 1.5 cm. in diameter. Walls 2 mm. in thickness and firm, containing a few trabeculae or spicules of bony substance. The surrounding marrow is unusually porotic and toward the periosteum is deeply congested. There is no eburnation at this point. The articular surface of the bone is perfectly smooth.

The radius measures 9½ inches in length and averages ½ inch in width. It is thickest at the bicipital tuberosity, where it measures 1 inch in diameter. It is curved acutely backward at the middle. The periosteum strips readily, leaving a granular surface. There is no apparent new periosteal growth. The cortex is dense, eburnated bone, for the greater part, encroaching on the marrow at the middle of the bone for 3 inches of its extent, so that no marrow is seen at the lower third of the bone. The marrow cavity at other points measures 6 mm. in diameter, the upper portion being hemorrhagic, the lower portion yellow and fatty. The lower epiphysis is congested. The thickening on a level with the bicipital tuberosity is denser at the posterior portion of the bone. The part immediately under the attachment of the biceps, although being eburnated bone, contains some fine porotic bone. The attachment of the biceps strips away with difficulty, leaving a rough, moth-eaten appearing bone beneath. The rest of the surface of the bone is smooth. The articulating surfaces are normal and no evidence of new periosteal bone is seen.

Clavicle: The clavicle is S-shaped in form, there being an acute anterior bowing 2 inches from its sternal end, the posterior bowing less acute toward the humerus. The bone originally should have been 7 inches long. The clavicle is 6½ inches in length and varies much in thickness. The innermost end up to the middle measures 2 cm. Here the bone gradually thickens until at the outer end it is 2.5 cm. in diameter. There is no marrow cavity left, but a wider meshing of the bone is noted at the middle, where it is congested. The acromial end is quite granular and more or less frangible, and not so dense as the other extremity. There is an irregular mottling of brown color at this end. The surface is finely granular and the periosteum strips off with a little difficulty. Elsewhere the periosteum strips readily, leaving a smooth surface beneath. Congested points more or less depressed are seen throughout this sub-periosteal bone (position of nutrient vessels). Similar points were seen here and there on the other bones. The sternal end is smooth. The cartilage is congested and almost

entirely gone at the acromial end, being as thin as a sheet of paper, but not quite eroded through.

Rib (a portion of the rib retained for examination): This rib measures a little more than 4 mm. in thickness, 2.5 cm. in width, and is very thin, being very much thinner, as if drawn out, at its upper border. There is no evidence of eburnation. The marrow is red, except at the sternal border, where it is only slightly pigmented. The sternal end of the cartilage has become ossified for the greater part. The periosteum strips readily, leaving porous bone beneath. In places there is a mere shell of cortex left. The upper extremity, however, shows a condensation of bone, and here tissues cannot be easily stripped from the bone. There are large openings here and there for nutrient vessels.

Vertebra: This specimen consists of one-half of adjoining vertebra ankylosed together. The substance of the spongy bone remains attached at the ankylosed point, showing the intermediate cartilage, which is in most part fibrosed, but at the contact with the spongy bone of the vertebra it is quite irregular and congested. At one point the vertebra spongiosa is very hemorrhagic, very porotic, and at its junction with the cartilage breaks away in nodular pieces, leaving smooth, glistening cupped areas behind. Here and there pieces of eburnated bony structure remain behind. These are rounded and nodular. The other vertebra shows a similar condition but is not nearly so congested. The surrounding ligaments tear away, pulling spongy congested bone with them. There is no evidence of new bone formation on the surface of the bone.

Nutrient Vessels of the Tibia: The nutrient artery removed from the nutrient canal of the tibia measures 4 mm. in diameter; it is thin, irregular in shape, glistening and soft. Its lumen is smooth and blood-stained.

All the bones can be sectioned with a scalpel. The rib is the softest.

MICROSCOPIC EXAMINATION OF FREE-HAND AND DECALCIFIED MICROTOME CUT SECTIONS.

Stains: Hematoxylin and eosin, carbol-fuchsin, alum carmin, Wright's, polychrome, methylene blue, and Gram's stain.

Tibia: The structure of the bone is erratic, consisting of abruptly ending trabeculae abutting against circumferential or interstitial lamellae of old bone. Between larger cancelli are included small pieces of bone looking like worn-down trabeculae. The points of con-

tact are always irregular, as if lacunar absorption had taken place and was recovered by new formation of bone or by crushing in of old absorbing bone. In some of these trabeculae there are ten to fifteen lamellae laid down. Where they come in contact with the Haversian canals they frequently show finely granular structure, faintly eosin-stained. Again, they are infrequently lined by a homogeneous eosin-stained lamella of new osteoid tissue. The lacunae as a rule are well formed in the interior of these cancelli of bone, but some of them are very big, bordered by an eosin-stained granular material, outside of which is seen a hematoxylin-stained granular border (see photo). In many of these lacunae, especially those bordering the canals and spaces, there are two or three nuclei and cells.

The marrow is myxomatous, with varicose capillaries, some of which are degenerate. There is very little fat in the spaces. The canal system is quite erratic, being made up of irregularly branching wide and narrow lines and broad spaces. Their borders are usually rough; some are smooth. Within them are seen very thin-walled vessels congested with blood. There are many new-formed capillaries in loosely meshed myxomatous tissue. It is not so fibrillar as that in the canals of the clavicle. The bone in the upper extremity of the tibia is extremely porous and spongy, yellowish in color, and consists of a meshwork of irregularly running trabeculae, many of them being moth-eaten in appearance. There is considerable fat and myxomatous tissue in this spongy bone which surrounds the multilocular cysts described macroscopically. The cyst walls vary in thickness and consist in the main of hyaline connective tissue with elongated nuclei. Here and there are seen eosin-stained bone spicules in the fat marrow. Forming cysts are seen as spaces, measuring 20 to 60 mm. in diameter, with a thin hyaline wall 10 mm. wide. A deeply eosin-stained oval or rounded mass is in the center. A few oval cells like bone cells lie within the spaces and in the connective tissue about them. These cells contain unstained circular spaces—possibly fat droplets. I take these to be bone cells. They are seen throughout all of the bones. The vessels about the cyst wall are degenerate and irregular in shape. The periosteum is not thickened over the tibia. The bone has a porotic, moth-eaten appearance at the surface, where it takes a deeper hematoxylin stain and is granular. Much brown pigment in cells and stroma. All cells of the articular cartilage are multiplying actively. The most evident proliferation is next to the bone. Here the cells and capsule

spaces contain much blood pigment. Many capsules are enlarged and broken.

Bone from the Bicipital Tubercle of the Radius: This resembles bone from the vertebra and clavicle, the erratic texture being most marked in the blunt ending of trabeculae and their moth-eaten appearance, the old Howship's lacunae having been covered over by new formation of bone. The spaces of the medulla are less marked here than in other parts of the bone, and there is a transition of the attachment of the biceps into a metaplastic bone, the tendon and muscle having become ossified. There is a transition of trabeculae through fibrous tissue to myxomatous tissue.

There are osteoblasts in rows on osteoid tissue covering and filling Howship's lacunae. There are areas where the newer bone has been softened, breaking up again into softened granular bone covered by polygonal cells.

The marrow is cellular and myxomatous. The vessels are small but varicose (irregularly dilated). Fragments of bone are seen in the marrow. Remnants of disappearing swollen lacunae with multiplying bone cells adjoin that portion of the bone next to the marrow. Here we see many remnants of bone cells in the shape of free oval nuclei. The bone and marrow are both pigmented with broken-down blood pigment. The main shaft of the radius resembles the clavicle in its structure. The bone contains much pigment.

Clavicle: The clavicle cuts fairly easily. It is granular in appearance and is made up of trabeculae which end abruptly, meeting cancelli coming from other directions, the line of contact being rough, as if it were the seat of old erosion. This border is hematoxylin-stained. There are no normal trabeculae; they are short, turned, and twisted. Many show lacunar absorption. The canals are widened and contain a fibrillar connective tissue with tortuous varicose vessels. These are lined by a single layer, broken here and there. Red blood-cells are seen in the surrounding tissue. Some canals contain groups of round and polygonal cells, some still lying in macerated granular bone tissue. Giant cells (osteoclasts) are seen here and there in grooves. Oval, round, polygonal and stellate cells are seen in transition. Free oval nuclei are in granular bone and marrow. The lacunae adjacent to the canals are enlarged, as are the bone cells within them. There are two nuclei in many of these cells. The contents of the canals in the main are of fibro-myxomatous tissue. There are a few osteoblasts and

they are elongated, flat against trabeculae. The bone absorption is the main process, and that appears to be by softening and metaplasia, and partly lacunar. There are no good vessels anywhere and there is less fat than usual. Many new-formed, irregularly swollen capillaries branch through the myxomatous tissue. There are many free red blood-cells and some normoblasts.

The bone and marrow are pigmented with blood. There are some areas of osteoid tissue covering the trabeculae of bone. There appear to be remnants of old bone, with its regular circumferential and Haversian lamellae caught in between the irregular formation of bone, the bone cells of old bone being smaller and more regularly parallel in arrangement. Those of the new bone are irregularly placed and not at all systematically parallel, and the cells and lacunae are larger than in the old bone. Some few of the old Howship's lacunae of absorbing bone are overlaid by a new bone layer outlined by a distinct, irregular, hematoxylin-stained, calcified line. A few trabeculae are lined by flat osteoblasts, but there is no evidence of recent functioning. (There is more osteoid in this bone than in others.) The periosteum is not thickened. The bone beneath it, however, is rough, due to lacunar absorption of old bone, and there are vertical clefts in the bony structure, filled with myxomatous tissue such as is found within the canals. Here irregular pieces of eroded bone, continuous with old bone, project into periosteum, and bone débris is seen elsewhere in periosteum. There are a few areas of polygonal cells where the bone is granular, showing a transition to stellate and longitudinal myxomatous cells. Free homogeneously stained nuclei, some containing vacuoles, are among them. Bone spicules are seen in the marrow spaces and canals, some of them lying between newly formed capillaries. The vessels appear as gaping, tortuous, and thin-walled, or as compressed fibrous bands. Many have hyaline walls; some are plugged with hyaline and granular thrombi. One larger vessel, a longitudinal canal, is in great part calcified.

In the articular cartilages are actively multiplying cartilage cells in oval and irregular spaces. There are areas of transformation into myxomatous and fibrous strands. In the area of greater softening next to bone are seen irregular lines of eroded bone. Calcification of the bone is evenly spread.

Rib: The rib is very thin, pointed at its lower border and blunt at its upper border. It is spongy in structure, with no well-defined

marrow cavity. The surface is rough. The periosteum strips readily. The periosteum is not thickened, but there is evidence of hyperplasia of adjacent and contained structures; the vessel walls are thickened; the nerves are hyperplastic, contain great numbers of Schwann sheath cells, and the perineurium is thickened; the muscle contains great numbers of nuclei, which are arranged, as a rule, in long lines, many of the nuclei being apparently confluent (see photo). There are in places clefts through the cortex adjoining the periosteum in which bone marrow is seen. These clefts seem continuous with vessels of the periosteum, several of which are full of bone marrow, possibly evidence of old bone which has been left behind in a bone-absorbing process. The main mass of the rib consists of trabeculae of spongy bone, most of which are very thin (20 to 30 mm.) and irregular in width, eroded by lacunar absorption. Some of them show strands of fibrous tissue as if reverting to their original condition. There is blood pigment in bone spaces, lacunae, and stroma.

Calcification is regular and evenly spread. The canals are most erratic in dimension and the course which they take, and are full of very cellular marrow. The cells of this marrow are as a rule large (15 mm. in size) where they adjoin the cancelli. They are frequently noted as polygonal in shape and in layers six deep. There is an unusual evidence of lacunar absorption, giant cells and old bone cells filling many of these Howship's lacunae and larger depressions in the bone. The vessels are small, numerous, and congested with blood. Only here and there can be seen any evidence of new formation of bone, and this is as a layer of osteoid filling the grooves on the trabeculae. At the lower border, where the rib has been narrowed and apparently drawn out to a point at the attachment of the intercostal muscles, there has been a metaplasia of soft parts into new-formed bone. A deeply hematoxylin-stained area adjoins the muscle attachment. A border of eosin-stained new osteoid bone with bone cells adjoins the above described porotic bone of the rib proper toward the interior. The upper border is rounded and shows evidences of osteoporosis. Canals from the bone proper are seen in the surrounding tissue. The vessels in the marrow at this point are degenerate, the media being particularly involved. At a point on the flat surface a widened canal filled with cellular marrow penetrates to the periosteum, and a linear longitudinal cleft filled with marrow cells lies between a trabecula and periosteum. A tortuous vein, 10 to 60 mm. in size, is alongside, between periosteum and

muscle. This is packed with such cells as are seen in the bone spaces. Many bone spicules are in tendon attachments. (This is evidence of bone absorption at the periosteal attachment.) Some of the trabeculae show evidences of edema, their lamellae are widened, and granular and bone lacunae with cells are enlarged. Here there is seen a transition from fibrous to cellular myxomatous tissue. The predominating cell is large (15 mm.) and polygonal. At one area there are so many of these larger polygonal and round cells in contact with eroded bone trabeculae that one must think of sarcoma. This was, however, seen only once in the many sections cut from all parts of the rib.

Vertebra: The structure is erratic, like that of the radius, clavicle, and tibia, but in the main the bone resembles the rib in its more cancellous structure and cellular marrow. Where the bone cancelli and plates are adjacent to the cartilage there are numerous wide coalescing lacunae and Howship's lacunae. That side of the cancellus of the bone next to the cartilage has been absorbed, until in some cases the Haversian canal with its contained marrow is in contact with the cartilage. The cartilage is calcified and fibrous; its cells have multiplied. The marrow is like that of the rib, but contains more small, round cells, normoblasts, débris, and fragments of bone. There is a mixture of dense masses of large and small round cells, some Heidenhain's giant cells and normoblasts. The vessels are numerous, thin-walled, irregular, bulging, and full of blood. There is free blood in the marrow, and loose, stained, stringy material (mucus) in parts of the marrow. There are areas of marrow which do not take the stain. These are necrotic foci. The bone cells, marrow, and lamellae are pigmented with blood pigment. The vessel degeneration is as marked as in the rib. Thrombosis and congestion are marked. Areas of necrosis in marrow cells are evidenced by the granular condition and lack of staining, accompanied by minute fragments of bone.

RÉSUMÉ OF THE PATHOLOGICAL FINDINGS.

It will be seen that the organs are the seat of arteriosclerosis, the media of the vessels being mainly involved, except in case of the aorta, which is covered with atheromatous plaques. The heart vessels are not much involved; the heart muscle itself shows brown pigmentation and enlarged, budding, increasing nuclei. The liver cells are pigmented; many nuclei very large and budding, and the organ is remarkably well preserved for such an old man. The kidney is the seat of irregular arteriosclerosis.

Some glomeruli are hyaline, others congested; there is hemorrhage into the tubules, which show a little parenchymatous degeneration, and the epithelium is still actively regenerative. The tubules which are dilated are lined by densely overgrown cuboidal epithelium with deeply stained large nuclei. The spleen is deeply congested and its capsule is very thick, containing a dense line of pigment next to the dense splenic substance. (Photo 19). Some of its larger vessels are bulged laterally by fibrous nodules in the media. The suprarenal shows a hyperplasia of the muscle elements of the medullary vessels and increase in ganglion cells. Some of its vessels have a calcified media. The lymph glands are very deeply pigmented (brown) and contain areas of hyaline fibrous nodules; there is no longer remaining a differentiation into its normal architecture. It is remarkable that with all the vascular changes we get such proliferation of muscle and epithelium. The bone changes vary in the different bones and in varying parts of the same bone, apparently due to changed static and circulatory conditions. These differences were noted macroscopically as well as microscopically. The vessel changes are most remarkable, and vary in amount in different bones and in the same bone. Degeneration is out of all proportion to similar changes elsewhere in the body. The nutrient vessels and degenerate vessels in the marrow are pictured (photo). The newly formed capillaries and small veins are distorted, varicose, and broken, and there are areas of hemorrhage and pigmentation.

Many vessels are occluded by hyaline or vascular thrombi. Some appear ossified, others fibrosed and incorporated in the newly formed bone.

The erratic formation of bone is remarkable. Bone absorption is going on both by lacunar absorption and by fluids (Von Recklinghausen calls it by vital fluid absorption as in osteomalacia). The new formation had evidently ceased for the greater part; evidently the new lamellar arrangements had occurred in by gone years by absorption and possible crushing of the modified bone. There are a few new osteoid deposits, however, covering the Howship's lacunae and lining trabeculae of older bone. There is no evident new bone formed from the periosteum in our case—maybe there had been long ago. One of the characteristic features is new formation and disappearance of new bone. One sees a granular condition of such bone with widened lacunae and enlarged *multiplying bone cells* in bone lining the canals. Many trabeculae gradually fade away at their ends where either fibrous bone and granular eosin stained material or polygonal and stellate cells are seen. Here, too, bone cells lie

free in finely granular bone and in adjacent spaces (See Bast and Haour). These large polygonal and round cells are most numerous in the bones which contain young (embryonal) marrow. I will refer to them again as seen so often by me in cases where vascular congestion with edema occurs in leukemic marrow next to softened bone and in osteoid tissue. Red blood-cells, normoblasts, large and small round cells, Heidenhain's giant cells and ordinary osteoclasts are seen. The marrow of clavicle and tibia is replaced by fibrous and myxomatous tissue. The rough surface of the bones is due to absorption as in the vertebra next the cartilage, in the rib next to the periosteum and at the radius tubercle (See photos). Haversian canals adjoin or have been left in adjacent tissues. I cannot explain the marrow-filled vessels in the tissues adjoining the rib and tibia in any other way.

The bone spicules not infrequently lie free or in the connective tissue of the marrow cavities. In one case a spicule is pictured lying between two degenerating capillaries. In the cyst walls of the tibia, spicules are present, and forming cysts contain degenerate pieces of bone. There is no normal marrow space—all canals and spaces run together and contain the same kind of material in corresponding parts of the bone. The widening of canals and spaces has its prototype in the individual bone lacunae, the Virchow bone territory about the lacunae, then a coalescing of these dissolved territories and lacunae to the larger canals and clefts. The lamellae of bone next to canals are frequently swollen and sometimes replaced by a linear network—fibrous bone in a metaplasia to myxomatous tissue.

In the vertebra alone are seen evidences of complete cutting off of nutrition by thrombosis. Here are areas of unstained necrotic cells and bone. The cartilages of radius and clavicle are thinned by metaplasia through fibro cartilage to myxomatous tissue. The vertebral cartilage is otherwise modified. In one place it is fibrous, in another there is calcification about multiplied cartilage cells, and nearby is seen a line of calcification where the lamellae of adjacent bone have disappeared. Calcification as a general rule is evenly spread. Only in those areas where absorption seems to be in an active stage one sees irregular splotches of granular hematoxylin or fuchsin-stained calcium next to a clear zone (see radius tubercle, photo 13).

The vessels throughout are bad—thin walled, varicose, sclerotic, calcified or thrombosed.

The nerves in periosteum and in muscle are hyperplastic. The Schwann

sheath cells are quite prolific and a dense *fibrous perineurium* ensheathes them. (Photo 17).

The muscle adjacent to all bones contains great numbers of nuclei. These are arranged in rows or are discrete. In some fibers the rows are so densely packed as to make it impossible to distinguish a single nucleus. They have a remote resemblance to the nuclear arrangement in young tendon. (Photo 18).

A similar nuclear multiplication is seen in other muscles of the body, but it is not so marked as in those attached to the ribs and vertebrae. The second case is of a very different type and should not be classed clinically with Paget's disease of the bones, but its pathology is like that of osteitis deformans. Czerny's original observation on osteitis deformans affecting single bones having been published in 1873, was referred to in Sir James Paget's original publication. Since the pathology corresponds exactly to the findings when many bones are involved and since it brings closer together the relationship between leontiasis ossea and local hyperostosis with osteoporosis, I include it here.

J. H. M., Male, age 64, came under my observation first in 1911, complaining of pain in and bowing of his right femur. He had pain in the back and joints, frontal and occipital headaches, but was otherwise well. No heart disease or vascular disease. He had typhoid fever and spinal meningitis at 17 years and suffered frequent attacks of malaria. He was shot in the upper right thigh when 20 years old, being laid up a long time. The bone was not fractured.

There is forward and outward bending with thickening of the upper third of the femur. No other bones involved. X-rays were made at the Johns Hopkins Hospital and in the Hebrew Hospital. Dr. Baetjer reports in May, 1913: coxa vara and Paget's disease of the femur and calcification of the pituitary gland; tibia negative; sella turcica normal; skeleton normal.

Last year patient had edema of right limb, with great pain and swelling at site of bending of his femur, due to phlebitis.

The femur has remained normal for ten years and his pains have disappeared excepting the frontal and occipital headaches.

Among clinical manifestations noted by various authors who have seen the bones of osteitis deformans, are valvular heart lesions, arteriosclerosis, pain, headaches, retinal hemorrhage, mania, neuritis, brittle hair, body pigmentation, scleroderma of spinal cord and brain symptoms, sarcoma and carcinoma of bones.

In Sir James Paget's descriptions, there were innumerable apertures for vessels, the whole outer skull being finely porous. All channels were enlarged. The grooves for vessels were much deepened. There was irregularity of density—the bone being both porous and like limestone. The periosteum was not visibly changed, not thicker or more adherent than usual. The outer surface of the walls of the bones was irregularly and finely nodular as in the case of deposits or outgrowths of bone. There was a greatly increased quantity of blood in the vessels of the bone. The medullary structure appeared as little changed to the naked eye as did the periosteum. The marrow appeared soft, yellow, ruddy, and bright crimson. The lacunae and cancelli had a normal aspect and arrangement. The compact bone was everywhere much thickened. There were areas looking as if the outer layers were separated. The walls looked like fine coral. The cancellous spaces were encroached on by new bone.

Mr. Butlin described the microscopic structure from the skull and tibia. The number of Haversian canals and systems in any given section was much diminished between the canals. The ordinary bone substance had numerous lacunae and canaliculi. The Haversian canals were enormously widened and confluent. In them was a large quantity of ill developed tissue and blood-vessels, leucocytes, fibres or fibrocells, few myeloid cells; fat too, especially in the skull. The vessels were small (normal) compared to the spaces. Some canals were lined by osteoblasts in a single layer like an ossifying membrane.

New bone was most evident in the periosteum of the tibia external to the compacta, but was much less developed than the cortex *from which it sprung*. There was no such similar finding along the marrow cavity as Butlin was led to expect *from its narrowness*. The number of lamellae about the Haversian canals was not larger than in the normal, but the arrangement was different and most complex. The lacunae and canaliculi throughout did not strikingly differ from those in ordinary bone.

Von Recklinghausen noted that it was difficult to judge under the microscope whether the new tissue was forming or in a regressive state. Osteitis deformans and osteomalacia were once confused. The cysts had smooth fibrous walls and were surrounded by fatty marrow. The cartilage of the head of the bone was thin—that of the head fibrillated. In one case of osteitis deformans there were cysts and fibromas. The diaphysis was the usual seat of cysts.

The bone and fibrous tissue about the disease seemed finished and normal. Microscopically, there was very little uncalcified osteoid tissue

and the soft connective tissue seldom young looking and rich in cells, but rather poor in cells and fibrillar. The cyst wall often resembled very old sclerotic connective tissue so that one looked upon the process as stopped—finished years ago. For a long-since ended process spoke the great firmness, the thickness, the perfect compact character of those osseous plates, which formed the very thin tumor layers with perforations, these being formed as part of the disease.

So we have before us a form of repair (healing) while the disease existed decades earlier.

Again he describes giant-cell myeloid tumors rich in granular brown pigmented cells in the new cortical substance. The periosteum takes little part in the formation of the new fibrous tissue rich in bone rods. The bone marrow and the bone tissue do the reproducing, hence the term osteitis fibrosa osteoplastica.

Certain bones seem to be preferred; yet all are involved. Those parts of the bone are most affected which do the most work.

The sarcomas, too, develop preferably at points of greatest pressure and traction. In these parts the compacta is thickest. In cancers with osteitis fibrosa he attributes the new bone and fibrous tissue formation in advance of the cancer metastasis to reactive irritation with inflammation. The circulatory congestion is marked. He notes that bone formation in osteomalacia prefers to locate at attachments of muscle and ligaments. He says:—

"Osteitis deformans or local osteomalacia is an osteitis deserving the added title fibrosa."

"The bulging lamellar arrangement is due to absorption (rarifying osteitis) preceding later bone apposition."

Packard, Steele, and Kirkbride:

Pathology: Excessive pigmentation of the skin of abdomen. Brittle hair growth. Spleen large. Giant-cell sarcoma of frontal bone with metastasis. Diploe present only in frontal and occipital bones. At base of brain the vessels are overfull. Clavicle cuts more easily than normal. Unaffected bone alternates with spaces due to absorption. These spaces are filled with a fibrous tissue reticulum, the cells being mostly spindle shaped and many round cells with deeply staining nuclei, polynuclear leucocytes, a few nucleated red corpuscles, and some fat cells. Most of the spaces are exceedingly vascular. In many vessels there is only one layer, this is of endothelial cells. No larger arteries are seen. The reticular layer runs almost to the periosteum—a thin shell of com-

pacta alone remaining. In the interspaces are numerous groups of giant cells. These cells lie on the edges of the unaffected bone, absorbing it. Running through these interspaces and the bone itself are masses of closely packed cells resembling osteoblasts with a fibrous matrix. This is evidently an attempt at formation of new bone, but in no place is it calcified. The dividing line between the new and unabsorbed bone is sharp and the processes are evidently distinct.

S*kull*: The distinction between diploe and tables is lost. There is a thin irregular plate of compact bone under the periosteum, but elsewhere it is honeycombed by absorption spaces giving it a porous structure. The spaces contain the same material as seen in the clavicle though not so many giant cells. There are plenty of capillaries, but no large arteries.

Stilling: Bone cuts easily. Some can be indented with the finger nail. Periosteum rich in blood, not thick, nor adherent, deep grooves for vessels.

The two tables of skull bones cannot be distinguished from the diploe —porous with a very thin compacta within and without.

Contents of Spaces: Red marrow. Some large spaces contain a fibrous tissue or fatty marrow.

Senile osteoporotic appearance of vertebrae. Findings in all the bones are similar. The Haversian and intermediate lamellar systems are often imperfect and abrupt, but very numerous. Where a vessel pierces a bone plate a lamellar system is seen. In some trabeculae the lamellar system may show parallel running lacunae, but in others these lacunae run in all directions. The separate cancelli are very irregular in boundaries; not one has a perfectly flat border. All are riddled with Howship's lacunae, perforated by canals and pierced by resorption spaces. Numerous Haversian canals pierce the continuity of the thin cortex. There are large numbers of giant cells in grooves. Apposition of bone is alongside of resorption. Resorption grooves are often covered by new osteoid with good osteoblastic lining. Often this bone is fibrous. The bone cells are often sparse and not always regularly arranged and the lacunae may lack canaliculi or have only short ones. The marrow in the worst involvement is of a streaked, very vascular connective tissue, sometimes rich in cells. These cells are spindle-shaped connective tissue cells with large nuclei, some polygonal with granular protoplasm. He compares the disease with leontiasis ossea and elephantiasis of the soft parts in younger people.

Elting, in reporting a case of osteitis deformans, very properly says: "The difference in anatomical findings of writers is probably because the disease was studied at different stages. The venous dilatation seen in certain cases may be an etiological factor, though this seems improbable." He thinks the bone pains are due to the distention of the periosteum as in rickets.

Higbee and Ellis: *Femur*—Compact portion 1.5 cm. thick. Much of the canal contains spicules of bone. Thick spongy bone is between canal and compacta. Marrow dark red and soft. Outer layer of skull cuts easily and is very vascular. The internal table is solid—dura adherent. Parts of external table are porous and vary in thickness from 1 cm. to 1 mm. Beneath this is a soft spongy bone or granular osteoid tissue in which are scattered nodules of relatively white, fairly compact bone. Internal layer uniformly solid but unevenly thick (.5 to 1.5 cm.). It is rougher than normal next to the dura. The mid zone is porous and friable. Pressure at the soft parts causes blood to gush from the inner surface. Microscopically, there is bone resorption and new fibro osteoid tissue. The Haversian canals of the inner table are very large and irregular, and some coalesce. There is new connective tissue about most of the vessels in the canals reaching to the bone, so that an endothelial lining to bone is not seen. The connective tissue is usually loose but is again fibrous. There are many giant cells in the Haversian canals of the inner table. They are within or on the border of the new connective tissue; many are close to the bone in lacunae. One field contains 58 giant cells. The mid zone (spongy mass) is made of small irregular islands of osteoid tissue and intervening structures of one or two types—dense acellular connective tissue and adipose tissue with a little connective tissue here and there. In this adipose tissue are a few mononuclear leucocytes. The adipose and fibrous tissue exceed the osteoid. Fewer giant cells are here. The osteoid contains bone cells but they look immature. Lamellae are seen in some fragments, but no Haversian canals. In the femur's more spongy portion, the connective tissue contains some large spaces filled with blood. No normal marrow.

There does not seem to be any essential difference in my findings from those of Sir James Paget, Butlin, Von Recklinghausen, Stilling, Packard, Steele and Kirkbride, Higbee and Ellis, Czerny, and Volkmann. The changes found in single bone involvement are the same as when many bones are affected. We will add to Von Recklinghausen's and Stilling's assertion that static, thermal, and vascular conditions are responsible for

the localization of the bone involvement that the blood-vessels are the source of the disease *in toto.* Paget himself classifies it as a chronic inflammation, the osteoporosis predominating over the productive changes. I would bring it in closer parallel to the general pathological processes that accompany chronic passive congestion. Here we have not infrequently intermittently overfilled vessels with edema and leakage followed by compensation by heart and vessels when repair and even excess of tissue formation occurs. This is best illustrated in the general pathology of the liver, heart, spleen, kidney, and even the bones when a long standing heart hypertrophy with irregular compensation exists. I have been in the habit of studying the bones from autopsies since 1905 and find without fail some of the changes found in the cases of Paget's disease in all cases of chronic passive congestion. The edema with widening (and sometimes granular condition) of lamellae, pigmentation of bone and lacunae, and pigmentation and large cell hyperplasia in marrow with frequent fibrosis.

In cases of cancer in the body, I have noted what is ordinarily called osteomalacia evidenced by an eosin-stained line looking like osteoid bordering the bone next the Haversian canals even when no metastases were present. The bone cells and large polygonal cells in the marrow next the bone described by Von Recklinghausen, Stilling, Packard, Steele and Kirkbride, Ewing, and Higbee and Ellis, are seen in my cases of myelogenous leukemia (photo 12), my bone transplant experiments (photo 21), cancer in bone (photo 11), sarcoma in bone, and wherever there is excess of fluid bathing the trabeculae, whether due to blood-vessel or blood fluid changes. Von Recklinghausen and Stilling refer to these changes as due to vital fluid coming in contact with bone. That the washing of the bone by fluid may modify the appearance of the marrow has its exaggerated significance and proof when we read H. Gideon Wells' report of myeloid sarcoma washed out of the bone, so that the typical appearance is no longer found in the marrow but can be seen in the growths elsewhere—as in the pleura.

Ewing, too, refers to this in describing the peculiar endotheliomas of bone, in which doubtless the polygonal cells described by him and those seen in our photographs are of the same origin.

The vessels have been described as congested, the blood gushing out on pressure.

Deep grooves are found along the bones (Baetjer describes such lines in x-rays in the cases of Hurwitz). Blood leakage, pigmentation of bone

and marrow are mentioned as a rule. There is no need to dwell on the relation of hyperemia, active and passive, to bone formation and destruction. I have written of it before. (See references.)

Spencer, in his Erasmus Wilson lectures, goes fully into this relationship, saying in brief that the bone changes are due to venous or arterial hyperemia.

Indeed this vascular hyperemia is the one condition on which all seem united, the deep grooves on the outside of bone and the wide spaces within being noted by all observers.

Those who have not seen pathological material have remarked about the arteriosclerotic vessels and heart pathology noted clinically (see Prince, Putnam, Hurwitz, Fussell, Fitz, etc.), yet the more minute examination of the vessels of bone and soft parts has seldom been made. When we note the frequency of origin as an infectious process (Edes, Watson, Painter, Franke, Czerny) and its comparison with elephantiasis, one cannot help but consider vascular thrombosis with later compensatory circulation as part of the pathology.

That bone formation and absorption are intimately bound together with vascular hyperemia was long ago proven (Spencer, Von Recklinghausen, Stilling). More recently experimenters have been able to cause metaplastic formation of bone in unusual places such as in the kidney by producing vascular hyperemia (see Harvey, Pearce, Asami and Dock). How the vascular condition is inaugurated has been left open by most observers, but congenital and acquired syphilis have had a large number of believers (Lannelongue, Achard, Fournier, Etienne, Oury and Claude). Claude and Oury reported Paget's disease and tabes in both mother and daughter, a case of Paget's disease in man and wife and that antisyphilitic treatment benefited six cases (Milean). That other infections, such as malaria (see Painter) might possibly be responsible is not to be lightly considered. Sir William Osler reported a case of blocked circulation with multiple gangrene in malarial fever and mentions the close relationship between malaria and Raynaud's disease (quoting Barlow and Monro).

Streptococcus, typhoid, and influenza germs have been starting points of infections which ended in either local, symmetrical, or finally generalized osteitis deformans (see Edes, Franke, Watson).

That it is originally a trophic condition and depends on spinal cord or peripheral nerve pathology has votaries (see Prince, Putnam

and Fitz). Maybe the scleroderma noted by Lewin, pigmented skin and rough hair (Packard, Steele and Kirkbride), may indicate a trophic change, but if their cases had such a grade of nerve thickening as seen in my photographs one can easily understand the skin changes as secondary to vessel changes as the basis of the entire process.

It is interesting to note Abbe's good results in operating on cases of osteitis deformans. One would expect to find readily healed tissues, for there is no evidence of active infection—no acute inflammation—and there are many potential osteoblasts present in the shape of liberated bone cells.

That the cells so frequently seen liberated from bone and plastered in its now granular matrix or against cancelli are capable of activity, either as connective tissue or bone formers, is not surprising. We have the authority of Bast, Koelliker, Arnold, Lossen, Macewen, Virchow, Shakspeare, to prove that bone cells may under good circumstances act progressively, the same as they may on other occasions act in a destructive manner. Koelliker has seen them coalesce to form the osteoclasts, in which case they must still retain some of the firmer texture of their original environment. Koelliker also describes them acting as osteoblasts. Again he has seen them separate into their original form. I have seen this, too, in bone absorption between dura mater and skull in bone, the seat of sarcoma and carcinoma, and in osteoid resorption after bone formation.

Fig. 21 shows these cells in case of formation and absorption of osteoid in experimental bone growth in muscle.

Watson's case, like our second case, suggests a local origin, possibly infectious. The right leg became inflamed, then the ankle, next the corresponding part of left leg was involved and on subsiding left pigmented spots. There was bending of bones with pain—the head later enlarging and the case developed into typical Paget's disease.

This case suggests others where erysipelas or other infections were the original source of trouble. See also Edes' case, which began with facial erysipelas. It also brings to mind the comparison made by Von Recklinghausen, Stilling, Gruber, etc., to elephantiasis following infections.

As to the pituitary, thyroid, and adrenal in their relation to osteitis deformans, I think endocrines go ahead acting in osteitis deformans, only they are dealing with modified vessels and tissues and their action

is exaggerated or moderated accordingly. There was evidence in my second case where trauma and phlebitis were apparently the basis for a local osteitis, that the pituitary was modified (calcified structures about it), but must have returned to a normal function later on.

Goldthwait, Painter, Osgood, and McCrudden, in studying the chemistry of osteomalacia, say "The normal function of marginal cells or bone corpuscles is so altered by certain substances that absorption occurs by them." Castration caused marked excretion of calcium. Castration during the decalcification period reversed the process.

McCallum and Voegtlin—"In osteomalacia, rickets, etc., the tetany is possibly due, as Erdheim suggests, to lesions of parathyroid gland." They prove that excess of calcium reduces nerve irritability, and reduction of these salts causes tetany.

The influence of internal secretions on vessels and other tissues through sympathetic nerves is well indicated in work by Orr and Rows, who say "The sympathetic system may then be held responsible for localization of atrophic and sclerotic changes in the spinal cord, *i.e.,* those supplied by pial vessels."

Those who find bone lesions associated with tabes and syringomyelia (Dercum, Spiller, Marinesco, etc.), will find evidence that the vessels, after all, may be the main source of trouble—the ductless glands merely exaggerating their anatomical and physiological weakness.

CONCLUSIONS.

We have, then, osteoporosis with disappearance of bone by lacunar absorption and chemical (vital fluid?) dissolution, accompanied by new formation of bone. In my case the new formation is not so marked as in those reported by others. The active process seems to have been completed.

There is evidence of breaking down of bone—I would say bending of trabeculae crushing down on neighboring cancelli, obliterating some canals and assisting in the formation of others.

There is marked vascular degeneration with varicose vessels, thrombosis, congestion, leakage with edema and minute hemorrhages. The surrounding tissues are modified to a certain extent as evidenced by changes in vessels, nerves, muscles, and tendons. It is suggested that this is due to the bone absorption in their neighborhood throwing them in contact with unaccustomed (unusual) neighboring material. In the case of muscle attachments the distortion and microscopical changes are especially marked.

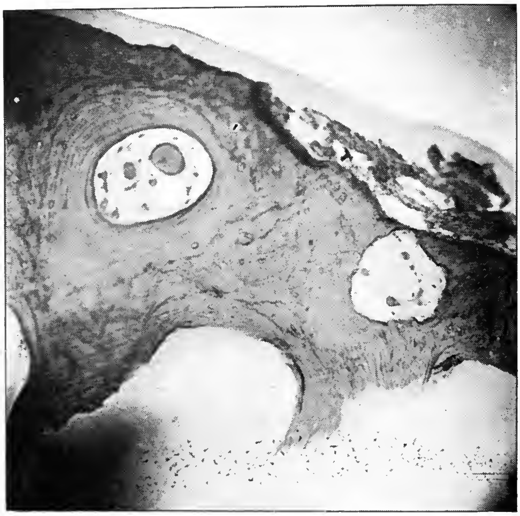

FIG. 1.—Tibia. At periosteum. Canal exposed. Myxomatous marrow.

FIG. 2.—Vertebra. Bone canals exposed at cartilage as bone cancellus is absorbed. Cartilage calcified.

FIG. 3.—Vertebra. Marrow exposed by disappearance of trabeculae of bone adjoining fibrous cartilage.

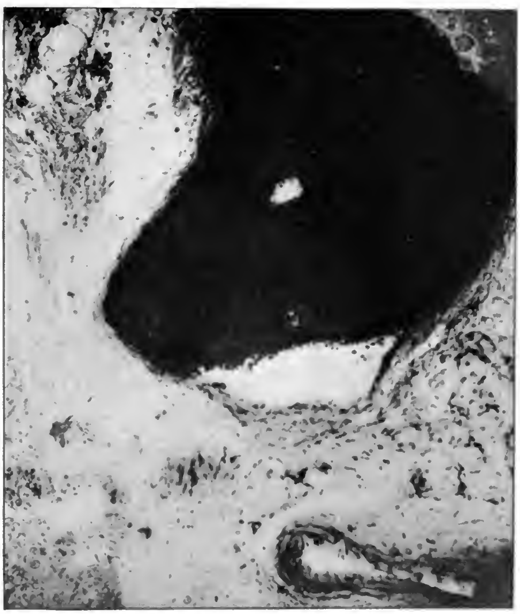

FIG. 4.—Rib. Vessel of periosteum full of marrow cells.

Fig. 5.—Rib. Narrow upper border. Bone metaplasia in muscle attachment. Large marrow spaces.

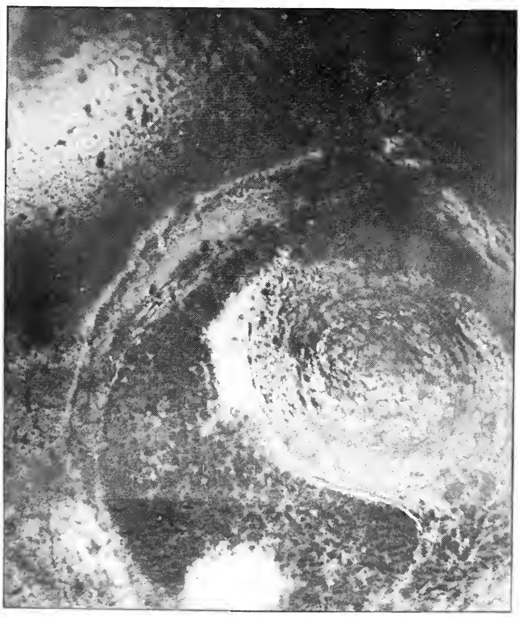

Fig. 6.—Rib. Broad lower border. Degenerate vessel in marrow.

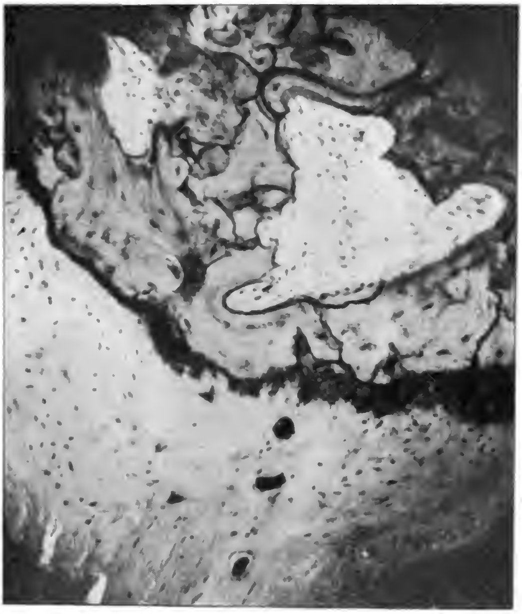

FIG. 7.—Radius at attachment of biceps. Erratic bone architecture. Bone absorption and new formation on the surface. Bone spicules and metaplasia in tendon.

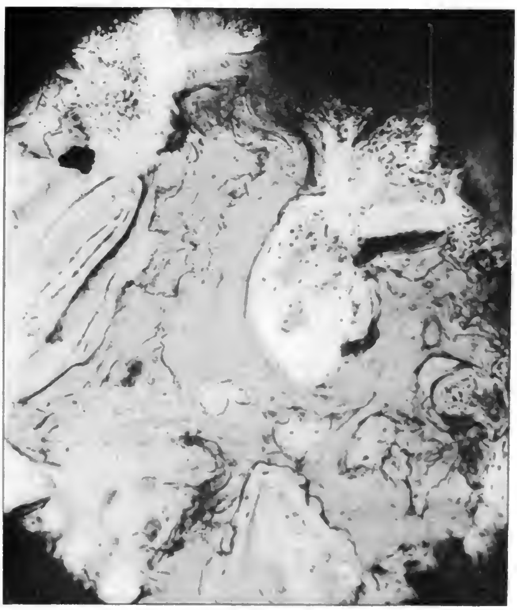

FIG. 8.—Clavicle. Granular bone. Erratic structure. Lacunar absorption.

FIG. 9.—Vertebra. Erosion of cancellus. Howship's lacunae. Cellular marrow. Many congested capillaries (pale). Little fat.

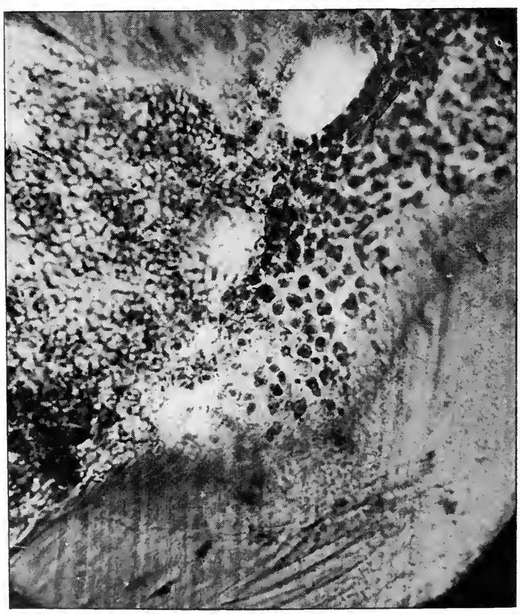

FIG. 10.—Vertebra. Polygonal bone cells of cancellus.

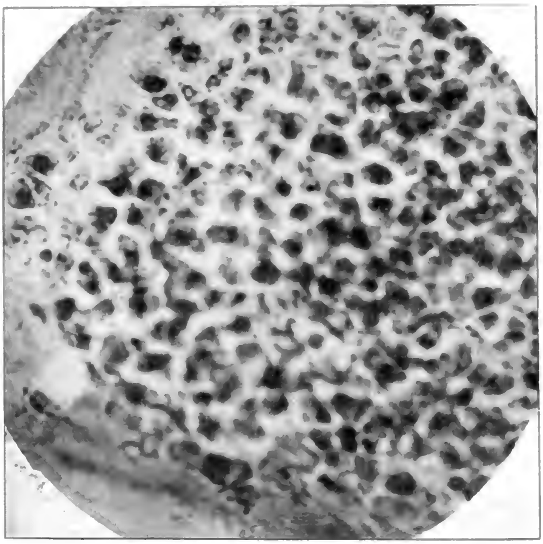

FIG. 11.—From a vertebra, the seat of carcinoma metastasis. Same appearance as in No. 10.

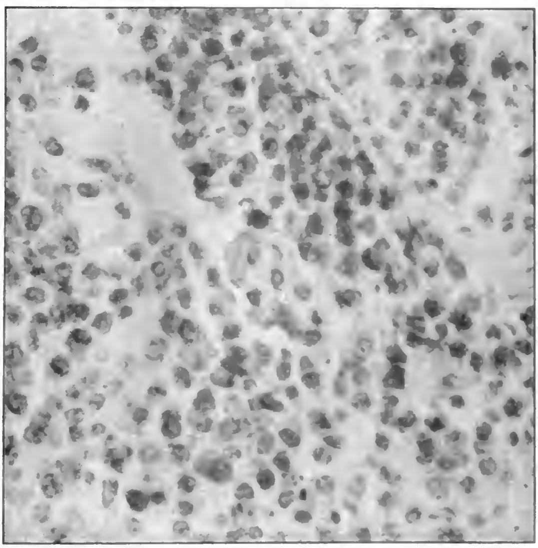

FIG. 12.—From case of myelogenous leukemia. Similar cells to Nos. 10 and 11.

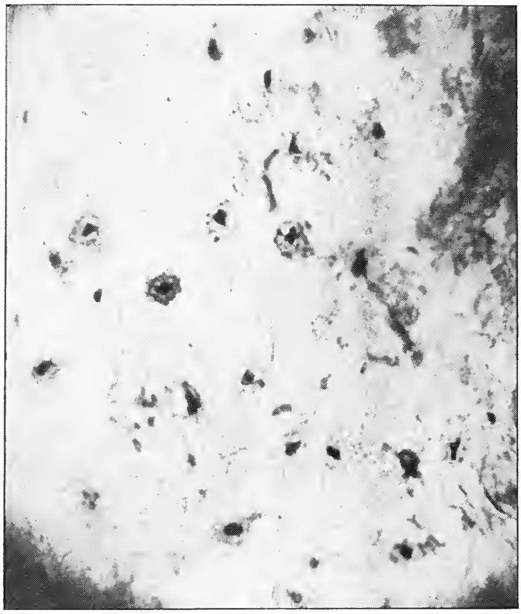

FIG. 13.—Radius. Resolving bone. Bone cells enlarged. Wide lacunae. Virchow's bone territories. Uneven calcification.

FIG. 14.—Tibia. Cyst wall. Forming cyst in adjacent fibrous tissue. Bone spicule undergoing disintegration.

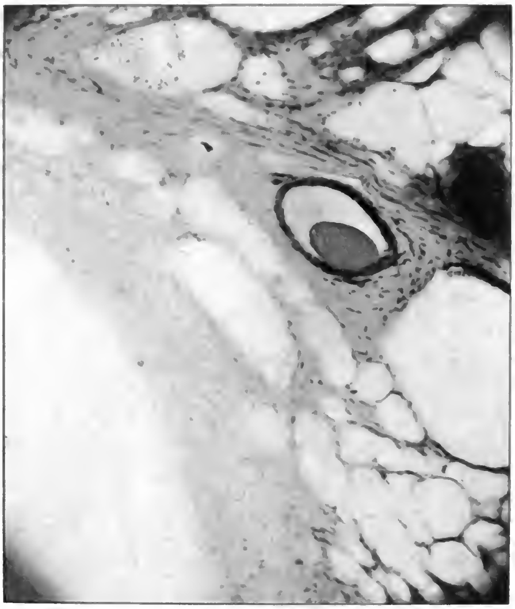

FIG. 15.—Tibia. Same as No. 14, with adjacent fatty marrow.

FIG. 16.—Tibia. Nutrient artery. Calcified media.

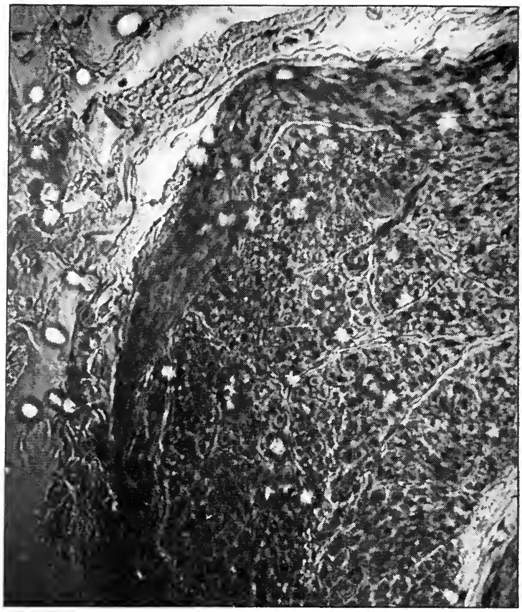

FIG. 17.—Rib. Nerve in periosteum. Nerve cells hyperplastic. Perineurium thickened.

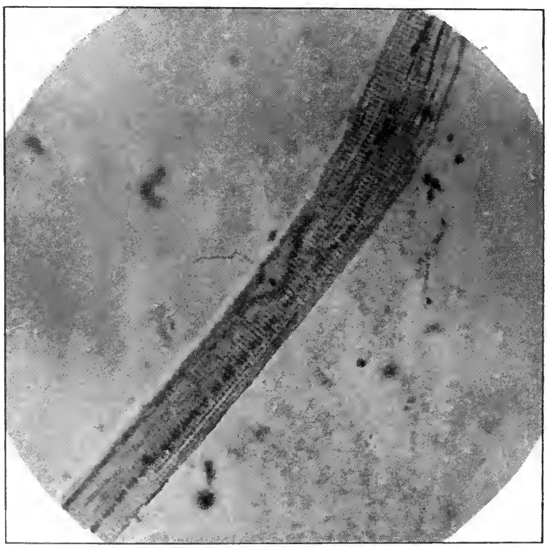

FIG. 18.—Rib. Muscle at rib. Nuclei increased and in rows.

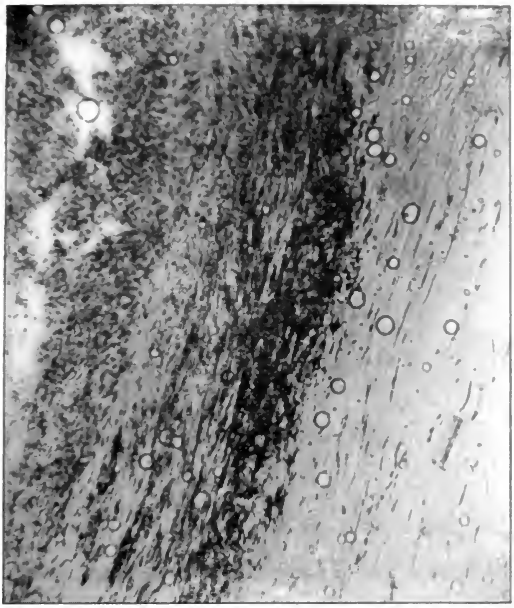

FIG. 19.—Spleen. Pigment deposit in deeper layer of thick fibrous capsule.

FIG. 20.—Sagittal sections of clavicle, radius, vertebra, and tibia.

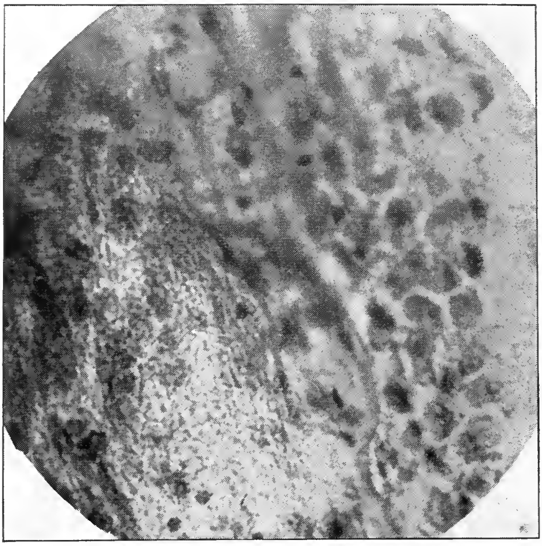

FIG. 21.—Polygonal bone cells. Transplant of bone into muscle. Experimental.

FIG. 22.—Polygonal bone cells. Edematous widened lamellae.

The bone itself shows reversion to a fibrous type in places; there is a metaplasia to myxomatous tissue and the marrow is myxomatous, fibrous or cellular, the bone cells taking part in the process. There is what appears as a reversion of marrow in some bones to the embryonal type—containing small and large round cells, megalokaryocytes and normoblasts—possibly compensatory. The bone cell multiplication is an essential part of the disease.

The pathological changes vary in the different bones and in various parts of the same bone. This will be noted too in the appended pathological reports of various cases by different workers.

There is evidence of analogous conditions to bone in the organs and tissues (see kidney, spleen, muscle), and nerves. This is best noted in the tendency to overgrowth-cell multiplication. The circulation has been erratic for years with intermittent compensation and the reverse, the bones, organs, and soft parts being correspondingly affected. The changes involved correspond to what one finds in chronic inflammation or in resolution of acute inflammation where repair is the most important factor.

My impression is that we have a primary blood-vessel pathology like one sees in syphilis, hereditary or acquired, with accompanying bone changes, such as one finds on a small scale in chronic passive congestion or infections of a chronic character. It is not at all improbable that malaria, typhoid, influenza, erysipelas, or parasitic germs could produce such vascular lesions, accompanied by local and general osteitis deformans.

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DISCUSSION.

DR. L. B. MORRISON, Boston: It has certainly been very instructive, listening to Dr. Cone's well-prepared paper. Unfortunately I know very little of the disease from the pathological standpoint, but literature up to the present time reveals that very little is known more than Paget discovered in 1876. In the past five years of my work I have seen something like 47

cases, which makes me feel that it is not a rare disease. There have been many classifications, but none seem to meet all conditions. I shall not attempt to discuss the paper, but by showing a few slides will bring out some of the points of interest. In going over my series I note this: that the changes in the bone seem to begin first at the cartilages and extend into the compact bone at the epiphyses. This is noted both at the knees and sacro-iliac synchondroses. It suggests an infectious origin. In comparing it with infectious lesions involving bones we get coarse trabeculation in the bone. In regard to calcification of the arteries, I believe this is an end-result rather than the cause in this disease.

Dr. T. Halsted Myers, New York City: Dr. Cone's paper is timely in that the etiology and microscopic pathology of Paget's disease, osteomalacia and osteopsathyrosis still present many unsolved problems. I wish to describe a case which combines symptoms of these three diseases.

Mr. N.; 43 years; W=95, H=4.11½. Chief complaint is progressive weakness of legs, and increasing deformities. Ten years ago first noted some weakness and instability as he walked. Gradual increase of symptoms, until the last six months he has had to use a cane, and after a block feels pain as well, in legs and hips. Never any swelling or inflammation in the joints.

Mr. N. seven years ago suffered for months with a severe attack of furunculosis and was in a week cured by taking brewers' yeast. He has had no other diseases. Eight years ago, following a slight trauma, he suffered his first fracture. It was of the right humerus and required three months to become solid.

While in St. Luke's Hospital, besides the examinations recorded below, he was examined as to his eyes, ears, nose, throat, and the cardiac, respiratory, gastro-intestinal, and genito-urinary systems, and nothing found which seemed suggestive as to etiology.

Examination of blood, December 14, 1921: Red cells, 4,900,000. Hg., 88 per cent. Leucocytes, 11,000. Poly., 77 per cent. L., 23 per cent. Reds, slight achromia. No poikilocytosis. No ova cytosis. No erythroblasts. White cells—No myeloblasts; no myelocytes. Blood cultures, December 17, 18, 19, 27—Negative. Chemistry—Urea nitrogen, 14.7 mg. per 100 c.c.; uric acid, 6.3; creatinin, 1.1; glucose, 77. Wassermann twice, negative. Urine (several times), 1020; acid, sugar, 0; albumen, 0, or slight trace. Never Bence-Jones proteid. No casts; few white blood cells.

X-rays showed a mixed process. There was great expansion of the diameters, some increase in length; decalcification involving both cortical and medullary parts, giving the bones a thin, spongy appearance, with a very thin cortex in most parts, though at points of stress thicker than normal. The decalcification also varied in degree in different parts, but never giving the appearance of cysts. There was also considerable increase in the density of the bone, very irregularly distributed, in small areas rather than in longitudinal striae, and in the medullary part especially. The bones involved were the skull, both humeri, both femora, and both tibiae, the entire pelvis and fifth lumbar vertebra. There were a number of small areas of decalcification, irregularly distributed in the flat cranial bones, and placque-like areas of increased bone deposit. The posterior clinoid processes seemed thicker than normal. The sella seemed normal in size.

On account of the pliability of the affected bones, the tibiae had bent forward and outward, the femoral shafts outward, and the necks downward to a right angle, while the sides of the pelvis in the region of the acetabula

had been pushed far inward and upward; the ilia had bent forward at the sacroiliac joint, and the promontory of the sacrum had fallen forward with collapse of the fifth lumbar vertebra. These deformities, together with marked increase in the size of all the affected bones, produced a very small as well as deformed pelvis. The gait was very similar to that of double congenital dislocation of the hips. The deformity of the right humerus at site of fracture is 90 degrees backward, and two inches below, the bone bends 90 degrees inward. The peripheral part of the bone here is irregular and enlarged, but not thickened. The line of demarcation between healthy and affected bone is quite distinct in the lower part of the tibiae.

Diagnosis: These cases are very rare, extremely so in this country. In England and Central Europe more are seen, and there have appeared a number of well-worked-out articles describing these conditions, but in none I have seen has there been described any curative treatment or any positive proofs of the etiology. There seems to be some relation between late rickets and osteomalacia. Osteopsathyrosis is a closely related condition, with localized decalcifications, repeated fractures, and imperfect reparative power. The appearances in my case are not those of any form of specific disease. The duration of the disease as well as the absence of any primary focus would exclude malignant disease. A number of his teeth have apical abscesses, but the x-ray appearances of the bones are not those of the ordinary forms of osteomyelitis. It seems probable that there is a metabolic process going on now, diminishing the amount of bone salts he deposits. Possibly this may be controlled by the ductless glands, especially those we know influence growth very directly. In this case the thickening of the clinoid processes points toward irritation, perhaps, of the pituitary.

Mr. N. has a sister, 38 years old, who is very small, and poorly developed mentally.

I wish to thank Dr. L. C. Wood, Dr. LeWald and Dr. Wiener for their help while investigating this case.

THE MECHANICS OF A NEW PLASTER SHELL IN THE TREATMENT OF POTT'S DISEASE IN CHILDREN, WITH LATERAL X-RAY CONTROL.*

BY R. PLATO SCHWARTZ, A.B., M.D.

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THE efficiency of apparatus which is elaborate in construction and of good appearance is too frequently accepted without conclusive proof. This paper will first present those fundamental principles which should always direct the treatment of Pott's disease, and upon this basis it will describe the mechanics of the posterior shell as an instrument through which these principles may be applied. The defects in the apparatus used heretofore have been recognized and their cause has been eliminated. The description of a new plaster shell is justified because it has thus far materially increased the efficiency of our treatment of Pott's disease.

The anterior portion of the spine is normally a flexible weight-bearing unit.[1] When any vertebral body becomes diseased, it forms a weakened link between the normal spine below, and the upper segment, which always bends in the direction of the greatest force,[2] while rigidity from muscle spasm attempts to immobilize the diseased area.

The nature of the lesion and the parts affected require that both mechanical and physiological principles be included in any form of therapy in this affection. These may be briefly stated as follows:

1. All superincumbent weight must be removed from the anterior portion of the vertebral column.
2. Spinal motion must be reduced to a minimum.
3. Deformity should be prevented, and when present, its prominence should be reduced by compensatory curves, and modification of the posterior spinous processes,[3] without separating the surfaces of the diseased vertebrae.

*Read before the Boston Orthopaedic Club, September 16, 1921.

4. General hygiene, good food, and heliotherapy should constitute an important part of any rational treatment of this disease.

Normal ossification is a slow process, and disease of any part of the osseous system, in children under sixteen years of age, should therefore be regarded as an affection of developing bone.

In normal vertebrae new centers of ossification continue to develop up to, and including, the sixteenth year,[4] and their epiphyses do not usually unite until the average adult is twenty-five years of age.[5] The infant's spine has two primary curves, the dorsal and sacral.[6] It is important to note that the cervical and lumbar curves are acquired characteristics, forced upon the spinal column by the normal erect posture, which is essentially one of effort. The lumbar convexity, which is greater than any of those above it, is the last to be acquired. This leads to the conclusion that in a growing spine, which has become diseased, deformity may be prevented, or, if present, the spine may still be made relatively straight, by placing it in a position which favors the formation of compensatory curves and modifies the shape of the posterior spinous processes.

The cords of these arcs form a continuous line which is the perpendicular of this column; *i.e.*, a perpendicular drawn from the tip of the odontoid process impinges upon the second and the eleventh dorsal vertebrae and forms the cords of these vertebral curves. The line, thus formed, when traced onwards beyond the lumbar vertebrae, falls at right angles to a line drawn across the pelvis from one acetabulum to the other. Thus the weight of the body is transferred from the spine to a strong transverse arch formed by the thick iliopectineal line, and thence is transferred to another arch constructed by the femoral necks.

The function of any vertebral body between the cranium and the sacrum is to support and transmit weight and facilitate the movement of the parts above it when the body is erect.[7] If the structure of a vertebral body is altered by injury or disease its treatment should be the same in principle as that applied to a similar affection of bone in the extremities. "Rest was the routine practice of John Hunter, the most efficient instrument of John Hilton, and the creed and ritual of Hugh Owen Thomas."[8] Today the value of rest is so generally recognized that it has become an essential agent in the treatment of all acute affections, as well as in many of the more chronic diseases. Only when all superincumbent weight is removed and motion of the affected verte-

bral bodies is reduced to a minimum can we consider the tuberculous spine at rest.

Pott's disease in children frequently produces a most distressing figure when treatment is neglected, and occasionally this is true when treatment is more continuous than efficient. It always modifies and usually prevents the development of the affected vertebrae and subsequently distorts the shape of the normal spine above and below the lesion.[9] The treatment of this disease should promote healing with a minimum amount of deformity when the patient reaches adult life. Such a result can be most assured only when the growth of the normal spine is permitted while the lesion is being treated. The prognosis of a tuberculous spine at a given level is determined by, first, the time at which the disease is recognized; second, the amount of destruction present, and third, the degree to which subsequent treatment limits the normal function of the vertebral bodies.

In early cases we may prevent the formation of a kyphos, while for those in which it has already developed, we may accept the deformity and attempt only to prevent its further increase, or we may attempt to reduce the prominence of the existing deformity while the affected vertebrae are under treatment. If the latter is our purpose, as it properly should be, then there are two methods by which it may be accomplished. Separation of the diseased vertebral bodies by strong pressure will decrease its prominence; or the development of compensatory curves in the normal spine will disguise the relative prominence of the deformity without disturbing that portion of the affected vertebrae which is most favorable for bony union. Since our ultimate aim is to deliver the patient to adult life with a minimum amount of deformity it follows that our immediate need rests in those measures which are most conducive to bone formation in the affected area. Any method, therefore, which will induce the formation of compensatory curves and modify the shape of the posterior spinous processes without separation of the surfaces of the tuberculous vertebral bodies is indicated in the treatment of this affection.

Apparatus can effectively prevent all motion and remove the weight from an extremity, thus enforcing rest of the limb while the patient is erect. But at present there is no splint for the spine which will meet these requirements and thereby prevent deformity during the acute stage of this disease. A back brace may reduce all motion of the affected vertebrae, but it cannot be tolerated by the patient when it

is applied with sufficient force to remove all superincumbent weight from the vertebral bodies.[10]

Apparatus as it has been applied has failed to relieve the erect spine from superincumbent weight and we are forced to consider a change of position in order to remove this crushing effect from the diseased area. Since the time of Percival Pott, who enforced prolonged rest in the prone position, by the use of setons and issues,[11] recumbency has proven to be an essential therapeutic measure in the treatment of tuberculous vertebrae.

During recent years heliotherapy has proven to be of distinct value in the treatment of all tuberculous affections. The most satisfactory results require a graduated exposure of successive zones of the patient's body until the whole surface is well pigmented, then the dorsal and ventral surfaces are alternately exposed for stated intervals throughout the day. Such procedure obviously requires a turning of the patient and enforces the employment of a method which will eliminate spinal motion during this action. In fact the daily nursing care necessitates such changes of position that the same requirements must be met even though heliotherapy is not employed.

The treatment of tuberculosis of the spine in the Children's Hospital, Boston, has never favored forceful correction of the deformity with anaesthesia. Under the direction of Dr. R. W. Lovett, there has been one continuous effort to institute a form of treatment which would conform to those essential surgical principles presented by this affection. The Bradford frame with pads, then the plaster bed similar to that which was applied by Fink[12] were both used to advantage in continuous recumbent treatment. At that time the acquired deformity was accepted and neither form of apparatus then at hand was designed to minimize its prominence. To meet this necessity the posterior plaster shell was made to differ from the original plaster bed in that it was cut transversely at the level of the apex of the kyphos and joined together by hinges on each side, while a long turnbuckle connected the head of the shell to a heavy plaster pedestal beneath the buttock. By shortening the turnbuckle the convexity of the shell was increased and hyperextension of the spine was secured. (See Fig. 1.)

Although changes in detail were made from time to time, and definite improvements resulted in better construction, the effect of this apparatus was anticipated but not proven. The apex of the kyphos always determined the level of the fulcrum in the posterior shell and its

efficiency was granted when pressure upon the kyphos was indicated by hyperemia of the skin. The first requirement, therefore, was to obtain direct evidence as to the effect which this shell was producing upon the diseased area and the spine as a unit.

Any index by which the progress of recovery may be followed in a given case and known lesion is of definite value. It is certainly advantageous, if not essential, to the patient that lateral x-rays of the spine be made at stated intervals during the course of Pott's disease. By this means definite information can be obtained, first, as to the recession of the active process; second, as to the rapidity of bone formation, and third, as to the efficiency of the apparatus in preventing deformity or decreasing that which is present. Lateral views of the spine with the patient in position on the posterior shell before and after hyperextension were, therefore, indicated.

The errors revealed by the x-ray were not surprising when the mechanics of the machine acting upon the spine were taken into full account. The posterior shell, when hyperextended, consists of two resistant, or relatively constrained parts, which by a certain predetermined intermotion serve to modify force so as to produce a desired kind of work, and it may, therefore, be properly called a machine. Through this device gravity acts upon the patient's trunk and head through two levers of the first class, over a common fulcrum, and the force of this action, *i.e.*, the work done by this machine, is increased each time the turnbuckle is shortened to increase the hyperextension. According to the laws of physics which govern this type of machine it is known that the greatest amount of work is done by the longest lever, when the weight to be lifted and the force applied remain constant. The point at which the most of this force is expended upon the anterior portion of the vertebral column lies opposite the centre of motion, *i.e.*, the fulcrum of the shell. In keeping with these laws it was found by x-ray that in lesions above the seventh dorsal vertebrae, hyperextension of the shell caused the apex of the kyphos to be pulled down on the distal portion, while in lesions below the eighth dorsal the kyphos was displaced on the proximal segment. It was demonstrated, therefore, that when the contour of the shell was changed from the level bed which it had formed, to two inclined planes, the patient's body, being loose within it, would shift in the direction of the lever which did the most work. There is only one level of the body at which the length and weight of the parts above and below would do the same amount of work when placed over a fulcrum. Displacement of the kyphos resulted, therefore,

Fig. 1.—Patient on posterior shell, hyperextended by turnbuckle. (Note, hip flexion and hyperextended knees.)

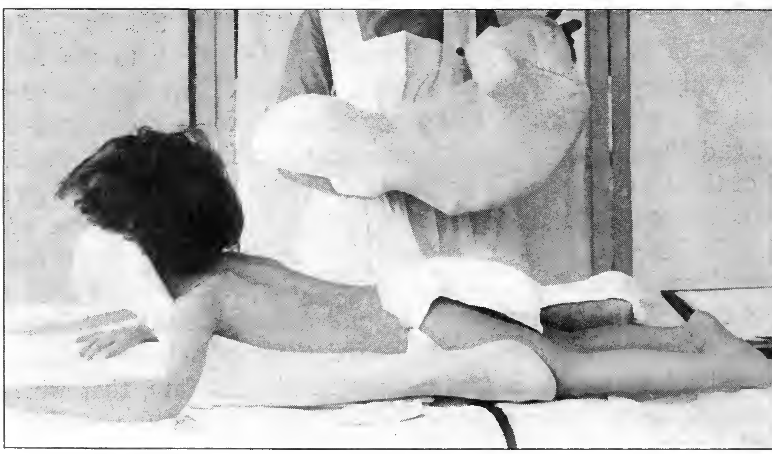

Fig. 2.—Patient on anterior shell. (Note, kyphos in dorsal region.)

FIG. 3—M. Y. Diseased vertebrae in apposition on admission. July 7, 1920.

FIG 4.—M. Y. Patient on old shell, without hyperextension, July 21, 1920. Fulcrum opposite apex of kyphos. (Note, diseased vertebrae are not separated.)

FIG. 5—M. Y. Shell hyperextended, July 21, 1920. Kyphos displaced onto proximal half. Compensatory curve created in lumbar region where least indicated. (Note, diseased vertebrae are not separated.)

FIG. 6.—R. Y. Diseased vertebrae, 2nd and 3rd lumbar, in apposition on admission, Jan. 9, 1920.

Fig. 7.—R. Y. On posterior shell with transverse cut placed at level of 1st lumbar. Note slight separation of 2nd and 3rd lumbar vertebrae which are distal to the fulcrum when the shell is not hyperextended. Jan. 13. 1920.

Fig. 8.—R. Y. On posterior shell, turnbuckle has been shortened, producing hyperextension. Note that the diseased area is now directly over the fulcrum and that the affected vertebrae are widely separated. Jan. 15. 1920.

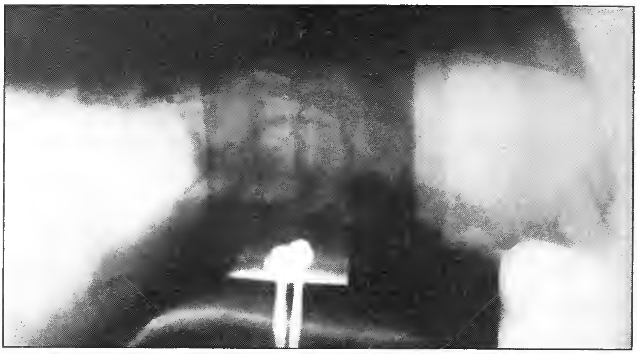

Fig. 9.—R. Y. On author's shell, Jan. 1, 1920. The 2nd and 3rd lumbar vertebrae, which rest in the center of the adjustable fulcrum, are again in apposition without recurrence of the deformity. Note the compensatory curves above and below the lesion.

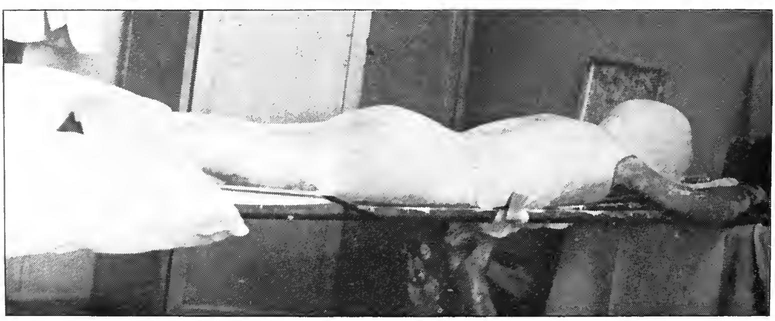

Fig. 10.—The finished shell is being removed by cutting the plaster in the midline anteriorly and spreading the sides well apart.

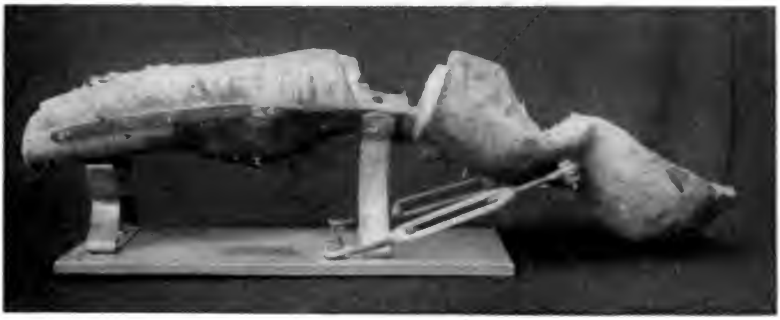

FIG. 11.—The old shell with the transverse cut, hinges, and turnbuckles. The notches in the sides provide for lateral x-rays of the diseased area of the spine.

FIG. 12.—The author's shell with adjustable fulcrum. Felt lining is in place and the stockinet cover is to be applied before patient is placed in shell.

except at this level, when the fulcrum was placed opposite the apex and the shell was hyperextended by means of the turnbuckle. When thus displaced, a compensatory curve was created in only one segment of the spine, and in the absence of any form of control there was grave danger of this curve being much greater than necessary or perhaps formed where it was least indicated. However, an advantage rested in the fact that when thus displaced, the corrective force applied was seldom of sufficient intensity to separate the diseased vertebral bodies, (Figs. 3, 4 and 5.) It is obvious from that which has already been demonstrated that hyperextension should be increased only when great care is employed, and frequent observations reveal that the force exerted is not sufficient to separate the diseased vertebral bodies, and in no case should it ever pass beyond that point where the deformity is definitely compensated by other curves (Figs. 6, 7, 8 and 9).

The level at which the fulcrum should be placed in order to work upon both segments of the spine has been determined by lateral views of the kyphos in a series of cases with lesions ranging from the third dorsal to the last lumbar vertebra. The estimates were made with reference to the amount of displacement which resulted from hyperextension when the fulcrum was placed opposite the apex of the kyphos, and the following figures are approximately correct.

The transverse cut should be located at these levels with respect to the apex of the kyphos.)

3rd	dorsal	vertebra	1½ inches below
4th	"	"	1 inch below
5th	"	"	¾ " "
6th	"	"	½ " "
7th	"	"	Opposite apex
8th	"	"	½ inch above
9th	"	"	¾ " "
10th	"	"	1 " "
11th & 12th	"	"	1¼ " "
1st & 2nd lumbar	"	"	1½ " "
3rd & 4th	"	"	1¾ to 2 inches above

The mechanical advantage of the posterior shell is essentially dependent upon its length as well as the position of the fulcrum. If the thighs are not supported, very definite objections result; first, the legs act as a lever of the first class over the end of the shell, as a fulcrum, and the lower portion of the spine is subjected to a range of motion which is not compatible with efficient treatment of this disease; second, flexion deformity at the hips is likely to develop; and third, hyper-

extension of the knees with relaxation of the ligamentous capsule may result from continuous strain thereon. (See Fig. 1).

Since these defects were demonstrated, this apparatus has been constructed in the following manner. It consists of a posterior shell and an anterior lid (see Fig. 2), both of which are made of plaster, the ordinary five-inch bandages being used. The posterior shell is made by putting a stockinet shirt upon the patient, from head to knees inclusive. A hammock is swung from a frame[13] (see Fig. 10) and the patient is placed face down with the arms at right angles to the body, and the apex of the kyphos is marked with an indelible pencil. The head, spine, and legs are held in the same straight line and the first plaster bandage is applied in continuous turns from the knees to the axillae. The plaster is then continued over the shoulders, neck, and head by half turns, which should extend well out over each shoulder and include each side of the head. Successive half-turns should then be applied to the back and thighs, extending to the mid-axillary line on each side, and the last plaster should make continuous turns as did the first. The posterior shell should not be more than one-half inch in thickness, and the neck should receive special attention, since it is most likely to be the weakest point. The shell is removed by making a longitudinal cut on the ventral surface and spreading the sides well apart (see Fig. 10). Immediately after removal the edges of the shell should be trimmed and a circular opening of ample size cut out for the use of the bed-pan. The transverse cut, which forms the fulcrum, should not divide the shell completely until two long hinges made of soft strap iron have been applied to the back of the shell. Two uprights about four inches in height are bolted to the lower half of the shell, which is then mounted to a long wooden base. With the distal segment of the shell thus firmly anchored, the proximal segment may be raised or lowered on the hinges which connect it to the lower half. In order to control the angle at which these segments shall rest, two turnbuckles are unscrewed to their greatest length and then bolted to each side of the neck of the shell. With the head of the shell at its highest point, the free end of each turnbuckle is fastened to the base. This done, the head may be lowered and held at any desired angle by shortening the turnbuckles. (See Fig. 11.) The shell is lined with gray felt and an extra thickness is placed along each side of the spine in the region of the kyphos. These are all held in place by wire thread and attached to only one segment of the shell, which is then entirely covered by stockinet, and oiled silk is sewed around the hole made to facilitate nursing care.

After completing the posterior shell and determining its efficiency by lateral x-ray negatives, the anterior lid should be made. With the patient in the posterior shell, a sheet of cotton is placed anteriorly and the lid is made to extend from the mouth to the knees by applying successive layers of plaster bandage in this direction. When dry, the lid is padded with a few layers of cotton and covered with stockinet (see Fig. 2).

The purpose of this anterior lid is to prevent motion of the spine while the patient is being turned. It is applied and strapped firmly to the patient on the posterior shell and after he is turned, the straps are loosened and the posterior shell is removed, leaving the patient to rest on the rigid anterior shell. (See Fig. 2.)

The time and skill required for construction of this shell, together with the x-ray evidence already set forth, suggested the need of a new apparatus, identical in principle, but essentially different in design, so that it would be more efficient and its application would not be limited to those localities where skilled mechanics are available.

A new shell which has been in use at the Children's Hospital, Boston, since June, 1921, was, therefore, designed by the author. (See Fig. 12.) It is decidedly less expensive, much more simple in construction, and up to the present time has proven to be mechanically efficient, although its true value is still to be determined. Careful x-ray studies of the limited number of cases now available have revealed four important facts which are in keeping with the mechanical and physiological principles essential to the rational treatment of this disease.

1. There has been no tendency toward separation of the diseased vertebrae.

2. Deformity, when present, has been materially diminished by the formation of compensatory curves in the normal spine.

3. The adjustable fulcrum should always be as wide as the diseased area and it is most efficient when placed opposite the apex of the kyphos.

4. Thus constructed and placed, the fulcrum causes the force of gravity to be spent first upon the normal spine above and below the lesion, while the initial deformity remains unchanged.

These advantages have been constant in each of the twenty-six cases now being treated with this apparatus. This shell is not cut transversely and the hinges are replaced by a fulcrum which is adjustable in both the vertical and horizontal planes. This fulcrum consists of a padded strip of aluminium which fits within the shell at the level of the kyphos. The fulcrum may be raised or lowered on two long bolts

to which it is fastened (see Fig. 12). These bolts pass through both the shell and an iron support which is mounted to the base under the shell at the level of the kyphos. A nut is screwed on each bolt after it passes through the shell and a second one is applied after the bolts pass through the rigid iron support. By means of these nuts the fulcrum may be raised or lowered in the vertical plane at the level of the kyphos. Openings in the sides of the shell at each end of the fulcrum provide for the making of the x-rays, and the anterior lid is applied and used as with the previous apparatus. The fulcrum as it is now applied splints the diseased area, and the corrective force is always centered upon the normal vertebrae adjacent to the lesion.

CONCLUSIONS.

1. The defects of the old shell have been revealed and it has been made a practical instrument through which the fundamental principles of therapy may be applied in the treatment of Pott's disease.

2. X-ray controls are necessary to prove its efficiency.

3. The fulcrum should not be placed opposite the apex of the kyphos except in the region of the seventh dorsal vertebra.

4. In lesions above the seventh dorsal vertebra the fulcrum should be made below the apex of the kyphos, one-quarter of an inch for each vertebra above this level.

5. In lesions below the eighth dorsal the fulcrum should be made above the apex of the kyphos, approximately one-quarter of an inch for each vertebra below this level.

6. The new shell with an adjustable fulcrum has thus far, on a limited number of cases, overcome the defects of the old one. It is much more comfortable for the patient, easier to handle, and much less expensive; besides being fully practical for treatment in the home and out-patient department.

This paper was made possible by the suggestions and criticisms of Dr. R. W. Lovett and Dr. J. J. Morton, to whom I am most grateful. I wish to thank Mr. J. V. Footman, Children's Hospital, Boston, for his work on the illustrations.

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THE DAVIS METHOD OF REDUCTION OF CONGENITAL DISLOCATION OF THE HIP-JOINT.*

BY WILLIAM JACKSON MERRILL, A.B., M.D., PHILADELPHIA, PA.

It seemed fitting to bring before the Association at this time a fuller account of the Davis method of reduction of congenital luxation of the hip-joint. Inasmuch as the method is used by a number of orthopaedic surgeons of Philadelphia and elsewhere, and as many are not familiar with the steps of the procedure, it is important that it be recorded as it was used by Dr. Davis in the latter years of his life. He evolved the method prior to 1903, for during that year he published monographs concerning his treatment of congenital hips. At the time of its conception it was a distinct departure from the violence and brutality which characterized a circumduction method, purloined and exploited at the beginning of this century.

It is here most congruous to pay, in some measure, tribute to the man who contributed, not only many eminently valuable measures to the art of orthopaedic surgery, but also many proofs of the wisdom and benefits of conservatism. He often said, "Surgery, by the very nature of the art, is *destructive;* orthopaedic surgery is *constructive.*" Every phase of his life was characterized by gentleness. It was that destructive factor, violence, that turned him to the development of a method by which the reduction of a dislocated hip could be accomplished "by the minimum amount of force, with the maximum degree of safety." He especially emphasized the employment of gentleness advocated by Paci, and denounced most emphatically the manoeuver of Lorenz, which was precisely Paci's method with the addition of destructive violence.

Davis had an exceptional knowledge of anatomy, pathology, physiology, and mechanics so nicely balanced that he was always master of the situation, no matter how serious. He reviewed the various results of open operation and the serious consequences following the injuries inflicted by violent bloodless methods. He made a thorough study of the anatomo-pathologic conditions, evolved his method, which elim-

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

inated some of the dangers and especially the violence of the circumduction method, urged gentleness, and emphasized the truth that the result is commensurate with the manner of treatment.

The Davis method employs*: direct pressure, flexion, internal rotation, abduction, and external rotation. It is as follows—*First phase*: The child is placed in the prone position upon a flat, firm table, having a square edge, and a firm, even padding sufficient to protect the ventral soft parts. The child must be so placed that the leg to be manipulated will hang downward close to the side of the table. An assistant fixes the pelvis by making pressure on it downward and toward the operator. An assistant grasps the foot and knee, flexes the knee, then flexes the thigh toward the axilla, internally rotating the thigh, making pressure toward the head of the femur in line of its axis, keeping the thigh close to the trunk. These movements are directed by the operator while he makes pressure on the trochanter downward and toward the tuber ischii. It is important to keep the thigh close to the body in the antero-posterior plane to prevent the head from moving inward and making direct pressure upon the sciatic nerve. The internal rotation relaxes the Y ligament and the external rotators. *Second phase:* When the head is at the posterior brim the operator grasps the knee and trochanter, extends the thigh toward the transverse plane of the pelvis, abducts the thigh, and within the bounds of safety makes pressure on the trochanter toward the acetabulum, at the same time gently rotates the thigh in and out. If by this means the head will not pass across the brim into the acetabulum the leg is placed in the position of the first phase and the head is pushed downward to the obturator groove. The resistant cases often require long-continued pressure, which must be firm but gentle, to carry the head across the brim or through the obturator groove. *Third phase:* when the head is at the thyroid foramen, external rotation and extension are made to carry the head upward through the cotyloid notch. *Fourth phase:* A plaster cast is so applied as to include the entire extremity, the thigh of the opposite leg, and extends to the lower thorax of the opposite side, when the luxation is unilateral. The same form of dressing is used for bilateral cases except for the lateral upward extension. The condition of the structures of the joint must determine the position of the extremity in the dressing. In the average case it is

*To avoid misunderstanding, an explanation of the movements designated in this article is here given: By flexion and extension is meant upward and downward movement in relation to the axis of the body. By ad- and abduction is meant movement anteriorly and posteriorly in relation to the sagittal plane.

as follows: The thigh is flexed, internally rotated, and abducted accordingly as is necessary to give the best position and stability.

Davis used, when necessary, extreme flexion, abduction, and internal rotation, and maintained this position (when he operated by two stages) until the resistant structures had yielded, before forcing the head to its desired position.

In the post-operative treatment Davis maintained flexion, abduction, and rotation until the x-ray and other clinical evidence indicated that the head, neck, and acetabulum would sustain the stress of weight-bearing without yielding, using casts or splints to sustain the position. The first cast was removed at the end of three to four weeks and the position of the head and neck was determined by palpation and x-ray. Casts or splints, reapplied at frequent intervals, secured the desired position and were substituted by an abduction brace until the roof of the acetabulum was capable of retaining the head.

When the bones were in a condition to withstand the stress of weight-bearing the patient began ambulation with the leg in the abducted position. Passive movements, massage, and exercises were given to hasten and insure the establishment of function. Long before his death he stated that there could be no fixed time for the bringing of the leg to the mid-line and the establishment of function: that each case must be handled according to the conditions found.

His method exercises a pressure rather than a leverage stress. By virtue of the mechanical principles involved, much greater force than is required by leverage stress to rupture sutures may be used with safety and the head pushed over or around the brim into the acetabulum. The leverage and torsion used in the flexion and rotation of the femur should be far below the limits of safety if the pressure stress be properly applied by the operator. When the head could not be pushed over the posterior brim of the acetabulum Davis manipulated it downward along the brim, forward through the obturator groove to the thyroid foramen and upward through the cotyloid notch into the acetabulum. In the older resistant cases when too great force has been required, he has operated in two stages. In the first, the head was pushed to the anterior plane, usually through the obturator groove and left at the thyroid foramen, the thigh internally rotated and abducted sufficiently, and flexed beyond 110 degrees and fixed in that position by splints or plaster. In the second stage, the head was pushed upward into the acetabulum and the thigh brought down to the desired position in flexion and abduction.

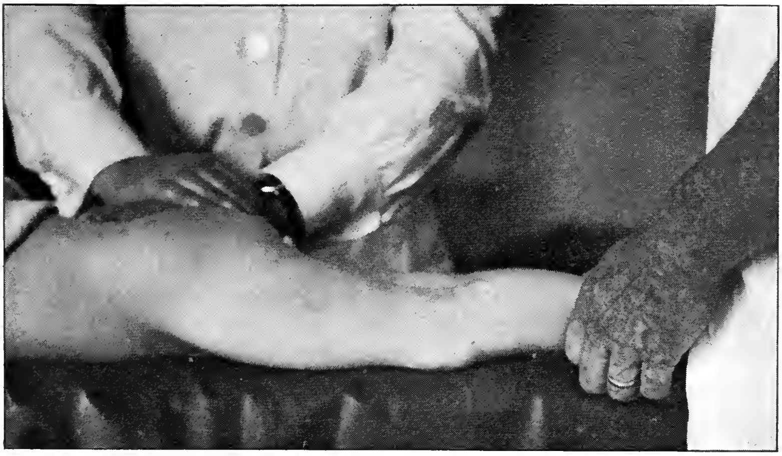

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

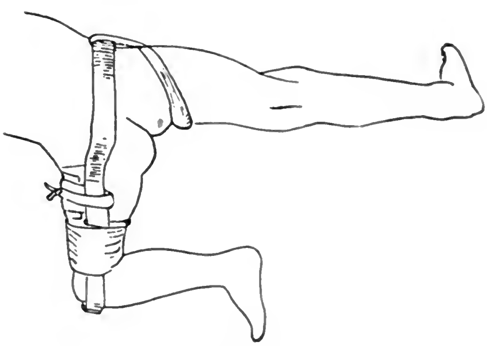

Fig. 8.

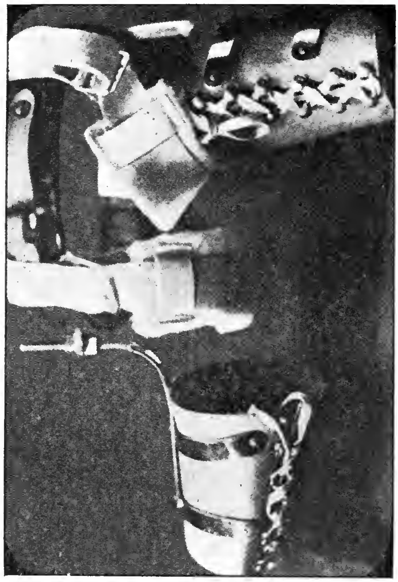

Fig. 9.

Davis modified his method in certain details from that which he used prior to 1910. The sand-bag was abandoned because it increased the difficulty in the control of the pelvis. Formerly when manipulating a hip-joint in order to promote the passage of the head to the anterior plane, he so placed the patient that the knee of the joint under treatment and the anterior superior spine of the opposite side rested on the table, and with the thigh in the horizontal plane of the pelvis, made pressure on the trochanter. This he discontinued because of the increased danger to the structures, especially to the femur. He laid great stress on the vital importance of keeping the thigh close to the body, also upon the necessity of internal rotation, this movement to be sufficient to bring the axis of the head and neck in line of the pressure exerted by the operator, to prevent a cross strain on the neck of the femur.

The efficiency and expediency of any therapeutic measure cannot be gauged by simple or even the average of conditions. It must be put to the severest test, under most adverse circumstances repeatedly, or else the conclusions are unwarranted. The easy cases of congenital luxation of the hip which are found only in the very young can be safely reduced by any method, if the proper care be exercised. This is not true of the more difficult conditions. At the present time long-neglected congenital luxation is rarely encountered, but a few cases are found, some of which

have a certain precocity of development and present conditions fraught with difficulties and danger, which increase inversely beyond the age of two years. The alteration in the structures caused by abnormal weight-bearing conditions and maldevelopment means that gentleness in its exact application must be abandoned and drastic measures employed. It is often desirable as well as necessary to use force, and comparatively great force can be applied if it be employed in the proper manner.

When the structures are distorted and resistant, prolonged force within the limits of safety must be used to bring the head of the femur from the posterior to the anterior plane. Davis tested his method by a very wide variation of conditions in children from one to twelve years of age.

Complete records of the results of treatment by the Davis method cannot be compiled, but his associates can bear witness that injuries to the structures were rare; moreover, that a high percentage of functional and anatomic cures were obtained.

It is unfortunate that the exact nature of some of his difficult cases cannot be recorded together with the splendid results he achieved in them, for such history would disclose his skill and gentleness much more fittingly than can the writer. He so handled every type of case that haematomas, extravasation, ecchymosis, paralysis, fractures, etc., were eliminated. Moreover, even a slight abrasion of the skin was rare.

DISCUSSION ON PAPER BY DR. MERRILL AND ALSO ON PAPER BY DR. Z. B. ADAMS
(Published in JOURNAL OF BONE AND JOINT SURGERY, July, 1922, page 523).

DR. RUSSELL A. HIBBS, New York City: Dr. Adams' paper has so many interesting suggestions that I wish he might tell us more of the details of Dr. Denucé's method.

In the first place it seems to me there must be more congenital dislocations of the hip at Bordeaux than we have in this country. At the Orthopedic Hospital in New York we have not reduced more than 350 in fifteen years. I know of no clinic in this country where such a number of congenital dislocations appear. I wish we might know more of the end-results, for, after all, that is the basis on which we have to estimate the results of treatment. As far as our work at the Orthopedic Hospital is concerned, I have felt for years that we must classify congenital dislocations of the hip more carefully. For instance, we consider one class, those with comparatively normal congenital dislocation—that is, with normal acetabulum, head, and shaft. I say comparatively normal, because none of them are perfectly normal. In this class we shall get better results than in any other. The other class, that is more difficult, is the one with torsion. Dr. Adams did not give me the impression that Dr. Denucé thought torsion was important. When torsion is more than 45 degrees I do not see how it is possible to get an anatomic correction.

As to the method of correction, our method is to correct the torsion primarily. Recently some of my associates have been correcting it after the dislocation has been reduced. That is for each individual man to decide. I am quite sure that our results at the Orthopedic Hospital are not quite as good as I should have said they were ten years ago. We are now making a study of all cases we are able to trace, covering the whole period of time that congenital dislocation has been treated by modern methods. When that report is complete it will be, I hope, very instructive to us and suggestive to others as to what the final results are.

As to the Commission Report, there is one point that impressed me as to what happens with the use of the machine that we use at the Orthopedic Hospital. The head is not pushed forward by the machine; it is pushed forward by the surgeon's hand. I think the Commission misunderstood the technic. In looking over these cases so far I feel that we have got a good many heads of the femur damaged but I think there were comparatively few of them damaged by the machine. I think the reason the machine prevents damaging the head is because it prevents it from making pressure against the ilium. The pressure is made against the trochanter by the trochanteric pad, and not against the head of the bone. Personally I feel that a machine which makes possible the operator exerting the whole pressure with his hand is safer than where a man has to exert the pressure with the machine.

Dr. E. W. Ryerson, Chicago: It would be very interesting to find out what the Committee thinks in regard to the after-treatment of these cases. You note the very wide discrepancy that exists between the method described by Dr. Adams as practised by Dr. Denucé and the methods with which most of us are familiar. In the Children's Hospital in Chicago we endeavor to get the child up and walking about, using the leg as soon as possible, with the idea of the possible stimulus to the growth of bone which normal use will make. Professor Denucé, if I heard Dr. Adams aright, advises no functional use whatever, no weight-bearing until eleven to thirteen months after reduction. It is barely possible that this difference in the treatment may have something to do with the development of the head of the bone. The results are very striking. I have now collected fifteen or more cases which were done many years ago, and, as Dr. Adams mentioned last year, we see a vast amount of difference between the head of the bone on the dislocated side and on the other side. Many of the cases have a great deal of traumatism during manipulative reposition and some do not. It would be interesting to have the Committee ascertain in an accurate scientific way whether the amount of damage done at operation has anything to do with the lack of development in the head in after years.

Dr. Walter Truslow, Brooklyn, N. Y.: I should like to ask Dr. Adams how much importance he places on one or two points he made,—the stroking of the adductor muscles, the use of strips of plaster as compared with our usual method of winding on prepared bandages, and the further muscle development of the femur.

Dr. J. T. Rugh, Philadelphia: Dr. Adams did not mention another point that has been strongly insisted upon,—that is, the further stretching of the flexor muscles of the thigh to bring the leg into complete extension. That has always been advocated to be done within the first two months. Now evidently

Dr. Denucé ties up this leg in a flexed position for six or eight months. When is stretching of the flexor muscles accomplished?

Dr. J. P. Lord, Omaha, Nebr.: I can very well see how this milder method of gently stroking the adductors will work in small children, three, four, five, or possibly six years of age, but in cases older than that I cannot conceive how it would accomplish very much. It is my experience that in some of the more difficult cases a very great amount of force is required, sometimes greater than I can give manually.

Dr. Reginald Sayre, New York: Dr. Adams says that after the leg has been manipulated it lies quietly on the table in extreme abduction, that is, it is brought down and manipulated and the head slips into the acetabulum. I can understand how it would, but I cannot understand how, with the gentle methods described, he is able to put the leg in extreme abduction lying flat on the table, because that means that you relax your tissues. As Dr. Lord says, in seven, eight, nine, and ten year old children, caressing it in that way seems to me extremely unlikely to get the leg into the extremely abducted position and having it lie there without resistance.

Dr. A. H. Freiberg, Cincinnati: I confess, perhaps somewhat rashly, that I am disappointed as a result of hearing Dr. Adams' paper. I had hoped for a demonstration showing that Dr. Denucé was doing something that we could not do and that the hips that were produced as a result of Dr. Denucé's method were entirely different from those we were accustomed to see. I hesitate somewhat to express the opinion that is really in my mind because congenital dislocation of the hip is not so frequent with us as in many other clinics. Quite the contrary, we see it rather rarely, so I have not had a very large experience; although in the years I have worked I have had more than a few and I must confess that I am rather satisfied as a result of the pictures I saw here, for they seem to have some bad femoral heads in France just as we have in this country. Nor do I see any greater amount of perfection in the observation of the final results than we have in general in this country.

I think we all recognize that a good many years ago we were all using too much force; not only more force than we are using now, but more force than was necessary. We were badly instructed. We began this method with force. Nobody knew how much force was required, and I look back with amazement to the manner in which we felt obliged to manipulate the hips of these little children. It took a while before we learned that this was not necessary. It seems to me that the manner of slipping the head into the acetabulum is largely dependent on the peculiarities of that hip. I feel that sometimes I can tell by the x-ray what manoeuver is going to be best in getting the head over the posterior rim of the acetabulum, but that is the way I nearly always get it in if I get it in at all. I am somewhat skeptical about methods of reduction. I remember some years ago Bade of Hanover came out with a good-sized book on this subject and I tried his method. In the first case it seemed to go well—the same way that Bade said it would—but no other one ever did afterward, so I do not think very much of that method of reducing a luxated hip.

I feel that I have had an insufficient demonstration of this method for judgment. Perhaps if I saw the method applied I should feel more favorably inclined toward it, but from the pictures we have seen there is nothing in the

Denucé method which is radically different from the methods we are using, and especially if we are using them with our brains and not only with our hands.

Dr. R. B. Osgood, Boston: I rise to the defense of Dr. Adams, and simply wish to testify to the experience we had in Boston. The testimony is not a personal one of reducing many hips, but in seeing many men in different parts of the country reduce many hips and then seeing the results in our own hospital in a large number of cases since Dr. Adams has been converted to Dr. Denucé's method. We have given him a chance to apply this method in this considerable number of cases in the Massachusetts General Hospital. Standing by him and seeing him reduce a hip is a very different thing from seeing a reduction by methods familiar to me in the hands of other men. There is no question in my mind and there is no question in the minds of the other men that the employment of force is very undesirable. The ease and quickness of reduction by these methods has been surprisingly pleasing. I wish Dr. Adams could demonstrate this method to you because I think you would be impressed in the same way that I have been. It is accurate, gentle, and apparently effective.

Dr. P. W. Roberts, New York: One point that Dr. Adams did not dwell upon that it seems to me he might tell us something about is the question of the capsule. We have to open a hip every once in a while where reduction is possible but where it does not stay reduced. Frequently we find that the capsule is contracted over the head and that is why the hip does not stay reduced. I would like to know Dr. Denucé's method in such cases. c

Dr. W. C. Campbell, Memphis: I should like to ask regarding spontaneous dislocation of the hip. In the study he has made of congenital dislocation of the hip, I wonder if he has had any reports of cases in which the head was in the socket from birth and later came out. I had such a case in a girl of eleven. A case was reported by Dr. Ridlon several years ago in which the acetabulum was very much like a saucer. The child walked very well for one or two years and then began to limp. When I first saw the child I felt it was a congenital dislocation and was able to reduce it very easily though she was eleven years old. I felt I had done a very good piece of work until later the hip on the opposite side came out. This had to be reduced at a later time. I should like to know if this type has been considered.

Dr. J. J. Nutt, New York City: I am very much interested in this after-treatment. I should like to ask Dr. Adams if, after all, the methods practised at Bordeaux do not bring about the same result as intra-articular pressure. I think it might be exactly the same as obtained with weight-bearing under regulation.

Dr. P. W. Nathan, New York City: It is rather surprising to me to find that we should still consider it necessary to discuss methods of reducing congenital dislocation of the hip. I have not in recent years found reduction in young children at all difficult. My difficulties lay not in the reduction but in the maintenance of the hip in place after reduction. This difficulty is caused by the anatomic conditions, namely, the partial or complete absence of the

acetabulum. It is evident that anatomical results cannot be attained if the head of the femur cannot be firmly anchored, no matter what the method of reduction.

It is my impression that in many cases, in which the ultimate functional result is poor, that this has been brought about by too forcible, or too often repeated attempts at reduction, over-zealous attempts to maintain the head of the bone in a faulty acetabulum, and rough manipulation as after-treatment. My own not inconsiderable experience leads me to believe that it is better to maintain the hip as near as possible to the rudimentary acetabulum for a considerable period, thus in many cases producing a false acetabulum and a good functional result, rather than lose this prospect by repeated reductions, etc. This is borne out by cases of uni- and bilateral congenital dislocation in adults, which were never reduced at all. A number of such patients walked without a limp and the anomaly was only discovered when these individuals were radiographed for other conditions. In these a well-developed pseudo-acetabulum was developed immediately above the rudimentary one.

I think our efforts at improving end-results in congenital dislocations should lie, not so much in the methods of reduction,—these are not so inadequate since the very forceful methods advocated by Lorenz have been abandoned,—but in devising means of maintaining the reduced head in the more or less rudimentary acetabulum. The method of Denucé, so well described by Dr. Adams, is no doubt valuable, but it does not appear to me that it is practical to carry it out when there are a large number of children to deal with in a city hospital. These children cannot be cared for at home in the manner described, and their maintenance in the hospitals, when all the requirements are fulfilled, is altogether too expensive at the present time, to make it feasible.

Dr. W. S. Baer, Baltimore: I think we all feel that in the past we have certainly used too much traumatism in the reduction of most of our cases of congenital dislocation of the hip. I think we all feel that damages have occurred about the hip, often due to traumatism. I certainly cannot reduce all cases, even up to seven years of age, with my hand; I often fail. Having failed, I put the case up in traction and allow the muscles to stretch for a period of two or three weeks. It seems to me, from what we have learned, that we get better results by proper traction, without hurting the skin or macerating the tissues, by a slow method over a long period of time, than by force. Our cases which fail of reduction at the first sitting are placed upon traction and are reduced in two or three weeks. The ease with which that head will slip into the rudimentary socket is very suggestive. Therefore, I am more and more inclined, as time goes on, except in very small babies, to put all cases up in traction and to produce stretching slowly, over a period of two or three weeks, before attempting any operative manipulation.

Dr. Charles A. Parker, Chicago: I want to express my personal appreciation of what Dr. Adams brought back with him. I think the rest of us, who did not take the trip, fail to appreciate the results. There is no doubt that he has more knowledge of the operation and treatment than he has given us in this brief paper. What I would like to ask is the age limit, higher and lower, of the cases treated by Dr. Denucé.

A word regarding the after-results: Five years of treatment will not allow us to determine what the final results will be on the head of the femur. I was

talking to Dr. Ridlon just before coming East and, as far as I could see from Dr. Denucé's method, the difference in the replacement of the head was that Dr. Ridlon keeps his great big fatherly thumb in front and on the head of the femur and he knows pretty nearly all the time where the head of the femur is. I do not know whether that is very much different from Dr. Denucé's method where he speaks of keeping the fingers behind and around the head of the femur. Dr. Ridlon wanted that particularly mentioned, that he keeps his thumb in front. He was one of the earlier members to reduce hips with a minimum amount of injury to the head, but with difficult cases you see Dr. Ridlon sweat as hard as any of the rest of us before he can get the head in, even when extreme force is used.

Dr. V. P. Gibney, New York City: I have enjoyed this discussion very much. I recall our early experiences and recall the traumatisms that followed manual reductions. I can recall one or two amputations after reduction and one or two deaths. I suppose, as these gentlemen have said, you who are in the habit of putting great force and pulling on the abductors feel that that is the proper method. We are apparently satisfied with our results and then after a while we begin to take stock and find that the head is not where we thought it should be, over the edge of the acetabulum. The parents are satisfied and the children walk with a minimum amount of shortening.

I did not hear Dr. Adams' paper. It seems to me we are still struggling with that deformity and still looking for good end-results. Dr. Gaenslen wrote me that they were looking for end-results, but I had to give him the same answer that I gave to the lady twenty years ago or more, who asked me if I could show her end-results. I told her that I could show a few. Then she asked me if I could tell her the name of the man who had done more of these bloodless operations. I told her he lived in Vienna. She had taken her child to the senior orthopaedic surgeon in Chicago and he had reduced one hip but was disappointed in the result of the other. Then she took her to the other man who said, as many of us do, that he did not get the case soon enough. I saw that same patient several years later, coming out of the dining-room in a Southern hotel, still limping on the left hip. I am not talking in the way of criticism; I am trying to be perfectly fair.

I have enjoyed this discussion very much.

Dr. Z. B. Adams, Boston (closing his part of the discussion): I cannot answer all the questions but I will do my best to answer some. Dr. Hibbs asked about the number of cases. I tried as hard as I could to run that question down. In Bordeaux and the territory from which these cases come there were five million people at the last census; in New York there are fifteen million. I wrote to Dr. Hibbs and he sent me the number of hips that he had reduced. I also wrote to Dr. Gibney and he sent me the number of cases that had been reduced in the Hospital for Ruptured and Crippled. There were nowhere near the number of cases that they had in Bordeaux; nevertheless, this hospital in Bordeaux is very old. The hospital is 150 years old and it probably takes care of all the cases, or nearly all the cases, that are found in that region, so that I do not know that we can compare it. Then we know that congenital dislocation of the hip is somewhat of a racial disease. It is unknown among the colored people and is very frequent among the French people. That does not answer the question.

About torsion, in this method I described, osteotomy of the shaft was not done. Prof. Denucé showed me eighty cases of end-results after three years after the plaster had been removed and he showed me none in which he had done an osteotomy in the mid-shaft. In most of the cases he does not do an osteotomy but allows the torsion to take care of itself. Now the surgeon's hands, after pushing the head forward (Dr. Hibbs spoke of his wedge), pull the muscles in between the head and the side of the hip bone and prevent the head from locking on the back edge of the acetabulum. He uses manual reduction in all of the cases.

I might answer Dr. Parker's question about the age. Dr. Denucé has reduced double cases in children up to ten years, but he does not expect to get good results in the older cases. The head has been deformed for too long a time. The after-results show 80 children with excellent functional results. He puts stress upon the after-treatment. It is not only the reduction and the gentleness that must be used in the reduction, but the important thing is the after-care, and he says that one of the greatest dangers after you have reduced congenital dislocations of the hip is the surgeon; that when you take the plaster off at the end of a month the hip may slip and the head get out of position. Therefore he leaves them alone and does not take the plaster off. He lets them alone for six months. I saw x-rays showing that during the six months the acetabulum is made deeper.

Dr. Nathan asked about hips slipping out after reduction. They do occasionally slip out, but I think the all-important thing is to be sure you put the head in. I have x-rays showing that it is possible to lock the head back of the socket, not in it; but when you take the x-ray in another plane, the head is found to be in another plane, back of the acetabulum. Therefore, when you take the plaster off it drops right back.

Dr. Nutt's question about intra-articular pressure I cannot answer. I do not believe there is as much pressure brought on the femur by moving the thigh in the air as there is if the thigh carries the whole body weight. I do not know whether that answers the question.

About spontaneous dislocations and dislocations long afterwards, Professor Denucé has had one or two cases dislocated long afterwards and he simply re-reduced those cases and went on just as though they were primary dislocations.

Now this method, although Dr. Freiberg does not think so, is really worth while. It is an easy way of reducing hips, and difficult hips. Dr. Sayre's suggestion that we are caressing the muscles is very good. You do not hammer them; you do not pound them; you simply stroke them. You get the thigh so it lies at right angles before you attempt reduction, and with little children that is possible. It takes from fifteen to twenty minutes to reduce a hip. Some of the men will substantiate that statement who have tried to do it under my direction. Dr. Ober is here and he did it.

I think that, in brief, is enough to say. There is a good deal I could describe, and there are various tricks to use to get the child to use the leg. A child walking in plaster does a great deal of damage. The head is cartilaginous, and if you put the weight of the child and the weight of the plaster on the head you may crush it and do a great deal of damage. We endeavor to get the hip so that it is almost functionally perfect,—that is, that the muscles have come back and are strong before any walking. This method prevents atrophy of the contracted gluteal muscles and the other muscles

of the thigh. In some cases there was some difference in the size of the thighs found in the end-results.

Dr. A. H. Freiberg, Cincinnati: I think I must have been misunderstood. I do not think I said that this method was no good. I simply thought the x-ray evidence which we saw was very much like what we have been seeing in our own experience.

Dr. Z. B. Adams, Boston: I could not show you functional results. All I could show you were x-rays. The results are functionally good—practically perfect in every case.

Dr. W. J. Merrill, Philadelphia (closing his part of the discussion): In addition I should like to bring a little emphasis on the after-treatment which Dr. Davis always used. In the after-treatment he used his braces to maintain abduction in a position required by the individual case. He kept the leg in abduction until the roof of the acetabulum was sufficiently formed to maintain the head in position.

THE REPORT OF THE COMMITTEE FOR THE INVESTIGATION OF THE BEST METHOD OF TREATMENT FOR CONGENITAL DISLOCATION OF THE HIP.*

JOEL E. GOLDTHWAIT, M.D., BOSTON,
Z. B. ADAMS, M.D., BOSTON,
DE FOREST P. WILLARD, M.D., PHILADELPHIA.

The committee that was appointed in 1920 to report upon the best methods of treatment for Congenital Dislocation of the Hip, and which made a preliminary report at the meeting of the Association last year, desires to report further, as follows:

A considerable number of cases has been studied, coming from a fairly large number of individual surgeons who have been trained in different schools, so that the material studied is probably as fairly an average of the work as it is being carried on today as can be obtained.

It is obvious at once that the anatomic conditions of depth of acetabulum, shape of neck and head of the femur, as well as the axis of the epiphyseal cartilage underlying the head of the bone, vary within wide range. That these features are of important consideration in treatment, and especially in the prognosis, there can be little question. It is urged that this part of the study of the cases, both before and after operation, be given more consideration.

In the cases which have been presented for study, the feature that perhaps attracts the most attention is the large number in which the head of the femur in the later pictures is either destroyed or very much misshapen, where the earlier pictures showed little if any malformation. This is so striking that to find cases in which the bones at all approach normal is by no means easy. That this is probably due to the violence used in the manipulation seems fair to conclude, and this opinion is strengthened by the fact that the proportion of destroyed or badly distorted bones is greater where the manipulative method involves much force than with those which are less violent.

This was obvious in the very early part of the study, and for that

*Read at the meeting of the American Orthopedic Association held in Washington, D. C., May 1-3, 1922.

reason was mentioned as a caution in the first report of this committee which was made last year. Since then the conviction has been strengthened so that this year the committee feels justified in making more explicit recommendations.

The committee is fully aware that many of the cases in which there is a badly damaged head of the bone, have very good function in the joint, but there is probably no disagreement that this is in spite of, rather than because of the anatomic disability. That so many have good hips is fortunate, but even the most ardent advocate of a method would hardly claim that a distorted bone is to be preferred to a well rounded one resembling that which Nature adopted as her normal.

In the beginning of the treatment of this condition, most of the methods involved the use of much force or, in the open method, involved extensive incisions with much damage to tissues. Since then the tendency has been to use less and less violence, but to make the reduction follow a better understanding of the mechanics of the hip-joint. In certain positions, to replace the bones requires the use of much force, and must damage tissues. In other positions, following the positions of physiological relaxation, replacement is relatively easy.

The methods which seem to best meet the requirements, and from which, once the methods are understood, we should expect the most perfect anatomical, as well as functional results, seem to the committee to be the method used and described by Dr. Ridlon, and the method devised and so extensively used by Professor Denucé of Bordeaux.

Probably in no method will there fail to be results that are not good, but it seems to the committee that on the basis of common sense, as well as scientific reasoning, the methods here mentioned will show fewer of these than with the other methods of which the committee has knowledge.

Of the machine manipulations, it seems to the committee that the appliance devised by Dr. Hibbs is least objectionable, and as a matter of fact is not wholly unlike the methods mentioned above, except that the forward movement of the head, once it has been placed low down, is accomplished by the machine instead of by the hand.

Correspondence

TUBERCULOSIS IN CHINA

The following letter, written from China in May, 1922, by Dr. Brackett, to the readers of the JOURNAL, arrived just too late to be inserted in the July issue, and is, therefore, printed now, although Dr. Brackett has already returned to the United States.

In a note which accompanied the communication Dr. Brackett says, "I can freely say that I have learned more how to take a broader view of many problems than I ever have before. No one who has not been here can form an opinion of the problems which confront these men, and neither can one form an adequate idea of the really fine way in which they meet them, handicapped to a tremendous degree. I am only hoping that this letter will reach you in time. It should if the disturbances which this country is undergoing do not delay transportation too much." The letter follows:

Pekin, China.

To the Readers of the JOURNAL:

It is of no special interest to those who have followed, even in a superficial way, the general medical conditions in China, to emphasize the fact that tuberculosis of bone forms a very large part of the surgical practice of the different hospitals and mission posts. The situation is not particularly different from that which existed in the United States twenty-five or more years ago, when a large part of the clinic of any children's hospital was comprised, not only of tubercular bone diseases, but also of these cases in the advanced and suppurating stages. Owing to the fact that the people in these countries are not yet educated to apply for relief in the early stages of these conditions, many of which are insidious, it is rare that they come under the notice of the surgeon until in advanced stages, and it is therefore distinctly true that this group, comprised of the later periods, forms a very large part of the work in the clinics, and it also presents the most difficult problems, and these must be met in some way with facilities which exist at the time and the place. The interesting feature of this situation is in its demonstration of the fact that it is always necessary to adapt principles of treatment to the equipment, both as regards personnel and physical equipment, which may be found at the time and at the place rather than to insist on methods of applying the principles: in other words, to apply the principles to the economic conditions. A study of the problems which are met by the men in this country, working with the handicap of limited personnel, meagre equipment, and of either apathy or superstition on the part of the patients, illustrates how much more important it is to have a thorough understanding of the principles of treatment and of the results which may possibly be obtained by their application, than of definite and fixed methods of applying these principles.

It also emphasizes the greater necessity of having in mind the probable, or at least the desired ultimate result, and this is particularly true when applied to those destructive processes which are found in bone tuberculosis. It also emphasizes the necessity that the original aim should be for the permanent and secure, rather than for a compromise, result, which may perhaps take the patient over a few years, but which will not stand the greater strain of later life, with the increased physical activity, increased weight, etc. In these countries it is very evident that the economic conditions under which the patients are placed necessitates the cutting out of the long period of conservative treatment, including the long period of convalescence, and of obtaining an ultimate and secure result in the shortest possible period. Many times this will be at a sacrifice which might be considered unjustifiable in many cases where conditions are more favorable. One must, therefore, resort to radical, which will be operative, measures, in these cases where under more favorable suroundings and conditions it has been the custom to spend many years in conservative treatment and where it is a matter of experience that this ultimately can be obtained. This is most evident, and at the same time it is most difficult to apply this principle to the treatment of these cases in children, and it not infrequently becomes a necessity,—in fact, there may be no choice, sometimes,—even to sacrifice a part. One should be able to derive a lesson from this, which may sometimes be applied when working under conditions far more favorable, as, for instance, in the United States,—namely, to have in mind, even in the early stages, the probable and desired end-results, as well as the principles of treatment, and to determine by what method this result may be most quickly and safely obtained. One cannot be satisfied to have as an ultimate result, after many years of treatment of an extensive destructive lesion, a joint which is unstable and which will demand a radical treatment after some few years of attempted use, when perhaps some earlier and more radical measures would have given the same result and without the long period of restriction and seclusion. The indirect but important and sometimes serious results of long conservative treatment are too often lost sight of until too late, and the lesson which intrudes itself while working among these cases and under the conditions which are found here, is the need of clear foresight, looking toward final results, trusting by the early recognition of these facts, to arrive at a decision which will not have too much the flavor of a compromise.

E. G. Brackett.

News Notes

Dr. W. A. Cochrane, F.R.C.S., Edinburgh, who has been practising in Boston, Massachusetts, for the past year, has accepted the position of Clinical Tutor at the Edinburgh Royal Infirmary, Edinburgh, Scotland.

BRITISH ORTHOPAEDIC ASSOCIATION.

SUMMER MEETING HELD AT SIR WILLIAM TRELOAR'S HOSPITAL FOR CRIPPLED CHILDREN, ALTON.

The summer meeting of the British Orthopaedic Association was held on May 26th and 27th, 1922, under the chairmanship of Sir Robert Jones, about 40 members and visitors being present.

The meeting opened with a demonstration of lantern slides at the Cinema, Alton, illustrating the methods employed at Sir William Treloar's Hospital in the treatment of non-pulmonary tuberculosis, with examples of patients before and after treatment. Some seventy slides were exhibited. The Hospital is the largest in the British Empire for the treatment of surgical tuberculosis; there are 314 patients under treatment. The treatment is called "conservative" and defined as "the adoption of all measures which tend to improve the patient's general health, increase his powers of resistance, and preserve and restore the part attacked." Sir Henry Gauvain then showed a cinema film of the application of a high plaster jacket for cervico-dorsal caries. A cinematograph film of a normal man walking and of several men wearing artificial limbs walking under the same conditions was shown by Mr. Elmslie. This film was taken with an ultra-rapid cinematograph at the rate of 160 pictures per second and the movement analysed by slowing the film to about 10 pictures per second. A short account of the results arrived at has already been published in St. Bartholomew's Hospital Journal for September, 1920, and in Mr. Muirhead Little's "Artificial Limbs."

The Association then visited Sir William Treloar's Hospital and College for Crippled Children, which was established for the intensive education and technical training of crippled boys between the ages of 14 and 16 years. The period of training is three years. Any type of cripple is admitted provided (1) he has the use of both hands, (2) that he is so physically defective that unless he receives specialized instruction in occupations suited to his limitations, he will be unable to earn his living. The methods employed have been extremely successful, and on completion of training the lads are capable of earning

their own living on equal terms with healthy competitors. The standard of work performed is so good that little difficulty exists in obtaining employment. The instruction is essentially practical, and the chief trades taught are leather bag, case, and trunk making, tailoring, boot making and repairing. The crippled boys are taught by special instructors, who have themselves been practical workmen, and their education is provided by selected teachers.

Cases were shown illustrating the mechanical methods of treatment in spinal caries and hip disease, comprising:

1. Spinal board for immobilizing and hyperextending cases of spinal caries, mounted on special stand for convenience in nursing.
2. Wheelbarrow splint for spinal caries with moderate deformity and psoas abscess or spasm. (Gauvain.)
3. Swinging back-door splint for correcting moderate residual deformity in spinal caries. (Gauvain.)
4. The so-called "Marconi" apparatus for correcting advanced deformity in spinal caries. (Gauvain.)
5. Tilting stand for paraplegia and other conditions. (Gauvain.)
6. High plaster jacket.
7. Celluloid spinal jacket.
8. Treatment of hip disease by webbing extension.
9. Treatment of hip disease by plaster extension. (Gauvain.)
10. Treatment of hip disease by plaster extension and immobilization combined. (Gauvain.)
11. Condylar clamp extension apparatus. (Gauvain.)
12. Plaster spica.
13. Winged celluloid hip splint.
14. Ischio-condylar metal splint (Gauvain), expansible and ambulatory.

The wards at Alton are arranged in two semi-circular blocks with ten radiating wards in each semi-circle. On the lesser circumference the wards are united by a 14-ft. curved balcony, and between alternate wards is a wide solarium, so that in inclement weather patients may be treated in the wards with open windows, during showers under covered balconies, and in fine weather in fully open, but sheltered, solaria especially designed for sun treatment.

All patients are educated while receiving treatment by specially selected teachers approved of by the Board of Education. There are 13 such teachers, working double shifts of three hours each. Each patient receives 1½ hours instruction both morning and afternoon. In the morning ordinary school lessons are taught; the afternoons are principally devoted to manual work. A piano is provided in each ward. The first approved English Hospital Nursery School for children under the age of five was founded at Alton, and special methods have been devised for instructing the patients. In the spinal ward for recumbent patients the lessons are lowered on to the patients by special apparatus.

In the centre of "A" Block is the Treatment Block, in the centre of "B" Block the Administrative Offices. The beds, stands, and cots on which the patients are treated have been specially designed for convenience in nursing the patients in the institution. All splints, appliances, and boots are manufactured in the institution.

The Hospital at Alton is situated on the southern slopes of the chalky North Downs at an elevation of 500 ft. above sea level. The estate comprises 130 acres and has its own poultry farm (100,000 eggs produced annually) and vegetable garden. The estate at Hayling Island is 60 acres in extent.

The marine branch of the Hospital at Lundy Point, Hayling Island, was visited on Saturday morning, May 27th; it accommodates at present 50 patients. The site was specially selected after the whole south coast of England had been explored. The Pavilion in which the patients are treated was specially designed for the work, and is so constructed that from the Sister's office patients in the ward, on the balcony; solarium or beach, are under constant supervision. At high tide the sea reaches the solarium, at low tide there is an extensive sandy beach. The hospital property abuts on a mile of private beach, which is available for treatment. The estate is situated at the extreme southeast corner of Hayling Island, remote from towns, to allow of undisturbed treatment. The coast is flat and sandy, there are no rocks or cliffs to interfere with the movement of patients. The rainfall is the lowest on the south coast of England; there is abundant sunshine, the heliotherapeutic value of which is assisted by the reflection of luminous and actinic light from the sea, which completely surrounds the hospital. There is wide tidal excursion. Absence of trees and rivers causes a clear atmosphere and freedom from mists. The South Downs to the north shelter the institution from cold winds. Heliotherapy is practised at both Hayling and Alton. Sea bathing at Hayling is possible and practised for eight months in the year, and paddling all the year round. In the winter sheltered coke braziers on the beach supply radiant heat to nude ambulant patients; recumbent patients are treated on electrically heated beds. Patients may thus be exposed to the air and sun throughout the year.

Patients are treated at Alton or Hayling, or at both institutions, as their requirements indicate, and are transferred by the institution's own motor ambulances. Treatment at Hayling especially induces very high metabolic activity and necessitates a very liberal diet. Very young or very weakly patients are not suitable for this marine treatment, which is also contraindicated in certain conditions, such as intestinal tuberculosis.

The effect of open air, heliotherapy, and balneotherapy have recently been very fully investigated at Alton and Hayling by Professor Leonard Hill and other workers of the Medical Research Council, who have shown that exposure to the open air very rapidly increases and maintains the basal metabolism of the patients, and that sea bathing still more rapidly and markedly produces the same effect. The technique employed in heliotherapy is fully described in "Tubercle," June, 1920. Professor Leonard Hill gave the Association a brief account of his investigations and conclusions.

In the practice of heliotherapy ambulant patients are first permitted to paddle, then are sprayed, and only later is complete immersion allowed. Recumbent patients are first sprayed, later carried into the sea in specially designed cradles. The period of immersion is carefully timed and only permitted to the degree of producing a brisk subsequent reaction. After bathing, the patients' feet are immersed in hot water, and hot drinks are given to produce rapidly the desired reaction. In selected cases very rapid improvement, both in the general condition and in the local lesion, ensues, the effect on sinuses being especially marked. The patients bathe in the open sea in a netted-in space, and are always accompanied by porters in waders.

INSTRUCTION IN HELIOTHERAPY.

In order to acquaint physicians with this branch of therapy and its technique Dr. Rollier and his colleagues at Leysin, Switzerland, instituted in 1921 a short course of lectures and demonstrations to which the medical profession are made welcome. This course was repeated in 1922 from the 15th to the 19th of August. No charge is made to those who participate.

The program for 1922 consisted of the following:

The Scientific Fundamentals of Heliotherapy,
Physical and Biological Study of Light, } Dr. A. Rosselet.

The Present Conceptions of Tuberculosis, Dr. Lichtenbaum.

The Practice of the Solar Cure for Tuberculosis. With Lantern Slides and Demonstration of Clinical Material. Dr. Rollier.

X-ray Diagnosis of Osteo-articular Tuberculosis and Radiographic Control of the Clinical Results of Heliotherapy. Dr. H. J. Schmid.

Heliotherapy of So-Called Surgical Tuberculosis and its Clinical Results. (Pott's Disease, Coxalgia, Arthritis, Adenitis, Peritonitis, etc.) Dr. Rollier.

Heliotherapy and Joint Function. Dr. Mieville.

The Work Cure and the Future of Convalescents. Dr. Rollier.

Preventive Heliotherapy, Lantern Slides. Dr. Rollier.

The Adjuvants of Heliotherapy (Radiotherapy, Artificial Phototherapy). Dr. Amstad.

Heliotherapy of Non-Tuberculous Affections, with Presentation of Patients.
Dr. Amstad.

Demonstration of Orthopaedic Apparatus Used in Heliotherapy. Dr. Amstad.

Heliotherapy and the Skin. Dr. Leuba.

Visit to the Heliotherapeutic Establishments of Dr. Rollier and Presentation of Cases. Dr. Rollier, Drs. Amstad, Alexandrowsky, Giauque, Lichtenbaum, Mieville and Schmid.

Visit to the "École au Soleil" and Demonstration. Dr. Rollier.

Very interesting excursions were arranged after the course. These included St. Moritz and the picturesque line: Diablerets-Sepey-Aigle. This course will be repeated in August, 1923.

Current Orthopaedic Literature

CONGENITAL DEFECTS.

PATELLA BIPARTITA. Hans Blencke. *Zeitschr. f. Orthop. Chir.* B. XLII., H. 5., S. 291.

Only a limited number of cases of accessory patella, patella bipartita, or supernumerary sesamoids on the patella have been reported in literature. The author adds two cases to those reported. Both have followed trauma and the patients have claimed compensation on account of the "fracture of patella." The differential diagnosis is, therefore, essential and important.

Patella bipartita is bilateral. Therefore, in all doubtful cases the injured knee should be compared with its fellow, to exclude traumatic fracture, calcareous bursitis, or spontaneous fracture which occurs in neuropathic bone affections of tabes, progressive muscular atrophy, etc.

The sesamoid of the patella is situated at the lower end or at the upper outer quadrant of the patella. The patella bipartita may be single or may consist of two or more fragments, all of which would give the form of the piece separated from the patella. The line of division from the patella is always smooth, sharp, without any corrugations, as could not be expected in any form of fracture, even if it were bilateral and painless as in the tabetic individuals.—*A. Gottlieb, M.D., Los Angeles, Calif.*

MADELUNG'S DEFORMITY OF THE WRIST. Brandes. *Ztschr. f. Orth. Chir.*, 1921, XLII. 1 H., page 20.

Ten years ago the author reported the cases of two sisters, 18 and 24 years of age, whose deformity had been inherited from their father. In a recent examination, it was found that the curve and expansion of the radius and the obliquity of its epiphysis had increased. The author considers that the primary condition is due to a disturbance of the zone of growth of the radius, with the bending of the radius as secondary to this. The disturbance of growth of the epiphyseal cartilage is congenital. In favor of this view are the occasional hereditary and familial occurrences and the simultaneous appearance of metacarpal brachydactylism. It is possible that the condition is the result of late rickets. The author considers Sprengel's conception excellent for other cases, i. e., that the torsion of the radial shaft and its volar and ulnar concave bending of the radius is primary.—*Armin Klein, M.D., Boston.*

CLUB FOOT OPERATION. Gaugele. *Arch. f. Orth. u. Unfall-Chir.*, 1921, xix B., 3-4 H., page 455.

The author reserves this operation for cases where, after two or three redressments in plaster, the adduction of the fore foot persists, and cases where the result is good except for the adduction of the fore foot, especially of the big toe. The big toe can, of course, be passively adducted, but in that case the outer border of the foot sinks downward, i. e., the base of the fifth metatarsal. If the outer border of the foot is pressed upward, the big toe becomes plantar flexed and adducted again. This is due to the fact that the outer border of the club foot is longer than the inner; the base of the fifth metatarsal opposes any straightening of the convexity of the outer border. For this reason the author removed, in several cases, the base of the fifth metatarsal and freshened the adjacent cuboid to get union. Incision was made lengthwise 1 cm. above sole. The operation immediately removes the hindrance to correction. The foot is put into a plaster cast, with the fore foot in strong abduction, with the big toe completely held in place by the plaster. The results are good, without any damage. The author has not always obtained union of the fifth metatarsal and cuboid because he removed too much of the base of the metatarsal.—*Armin Klein, M.D., Boston.*

OPERATIVE TREATMENT OF CONGENITAL ELEVATED SHOULDER ACCORDING TO KOENIG. Grauhan. *Archir. f. Orth. u. Unfall-Chir.*, 1921, xix B., 3-4 H., page 408.

Report of a case of a girl, 17 years old, with double-sided elevated shoulder, with lack of the lower parts of the cucullaris muscle. The left side was higher than the right. There was union of the transverse processes of the second and third dorsal vertebrae on the left to the medial border of the scapula. The upper part of the left scapula had grown toward the outer side, upward and forward, so that the supraspinous part was prominent at the front of the neck, and it was possible to raise the arm only 25 degrees above the horizontal plane. Because of this lack of power to elevate the arm and because of increasing deformity operation was performed. It was found that the lateral part of the scapula, with the condyloid process, had been separated from the medial part and drawn aside. The lower medial part, whose union with the vertebrae remained preserved, served to hinder any rising up without limiting motion about the ventrodorsal axis. The operation, which was essentially according to Koenig, does not interfere much, and does not damage the existing musculature of the trunk and shoulder. The cosmetic and functional result was so satisfactory that the operation for the treatment of elevated shoulder blade is worthy of repetition.

The operative procedure is as follows: The incision was to the lower half of the medial border of the scapula. The periosteum was split and elevated. The medial span of bone (wide as a finger) remained united to the dorsal vertebrae. The lower corner of the lateral part was drilled through and then the whole lateral part was very easily dislocated downward about three or four cm. The medial and lateral parts were then united by two wire sutures. Through the

hole in the lower corner of the scapula, according to Koenig's method, a strip of muscle fascia was drawn.

Gymnastic exercises and medico-mechanical postoperative treatment followed. A short time after the operation the left arm could be elevated to the perpendicular plane.—*Armin Klein, M.D., Boston.*

CONGENITAL ANATOMICAL DEFECTS OF THE SPINE AND RIBS. James Warren Sever, M.D., *Boston Medical and Surgical Journal,* June 15, 1922.

Dr. Sever has given us an exhaustive anatomical study covering such matters as theories of ossification, numerical variation, and defects of the vertebrae and ribs in the cervical, thoracic, and lumbar regions of the spine. There is also a statistical list of anatomical findings and a report of cases. The paper is illustrated by 40 excellent photographical reproductions of the surface anatomy and of the bony structures as revealed by the x-ray. The conclusions quoted below can scarcely be improved.

"It is obvious, even after studying such a large series of cases, that no very definite conclusion can be reached as to the cause of such vertebral and rib defects. One can only fall back on the original morphological and embryological theories, and can be content to exhibit these cases as examples of such developmental faults as nature saw fit to impose. That many of them cause serious structural defects and scoliosis is not questioned, and the problem can be met, at best, only by such external corrective methods as one can employ."—*H. A. Pingree, M.D., Portland, Me.*

A METHOD OF PROLONGED RETENTION IN THE TREATMENT OF EQUINO-VARUS IN THE NEW-BORN. Lucien Michel. *Revue d'Orthopédie,* January, 1922, page 65.

If treatment of club feet is begun at birth the condition can be completely cured in more than a third of the cases and the deformity can be ameliorated in every case. Unfortunately, however, the results are rarely definitive and the real problem is to maintain the correction and prevent relapse.

The objection to most forms of braces for holding the feet is that they are rigid, and since they must be worn many months they cause atrophy of the muscles. Another objection is that they have their point of support on the same leg as the foot which they are supposed to hold, and on this account it is impossible to prevent inward rotation. To obviate these difficulties Nové-Josserand has devised an apparatus of spring and aluminum which has a point of support on the opposite side. This idea is not absolutely new, since Neil and Heusner have used braces with support on the opposite side.

The foot piece is cut out of aluminum from a paper pattern made from a tracing of the foot. It has flanges to enclose the heel and one flange coming up around the mesial side of the foot anteriorly. The two foot pieces, right and left, are then set at the abduction angle at which it is desired to hold the feet and a bar of spring steel fastened on to the soles of the braces joining them together. This steel spring is about 1 cm. in width and 15 to 20 cm. in length, and is fastened to the soles of the braces by being passed through slits in the metal, and held by bending down a flange on the outer edge of each brace. It is easily detachable from the braces.

The method of applying the apparatus for double club foot is as follows: The sandal-shaped aluminum braces are strapped on the feet, then the steel spring is inserted joining the feet together. Finally, in order to produce the required abduction of the feet and outward rotation of the legs, a bandage is applied encircling both legs as a whole from the knees down about half-way to the ankles, binding the legs together. If it is a unilateral case the brace on the normal foot has a bar running up the inside of the leg which prevents valgus deformity of the good foot. In rebellious cases the foot piece is made in two parts, a heel piece and toe piece, the latter pivoting on the former in such a way that abduction can be increased when desired.—*William Arthur Clark, Pasadena, Calif.*

PARALYSIS.

Post-Diphtheritic Paralysis. T. J. Elterich. *Pennsylvania Medical Journal*, April, 1922.

A report of two cases of post-diphtheritic paralysis involving the heart or diaphragm. In one, death may come very suddenly. In the other, the general weakness may come on more slowly. The prognosis is very bad. The occurrence of paralysis is not prevented by antitoxin, but the occurrence seems to be less common the earlier the antitoxin is given.

In a case of the second group above, recovery was obtained by the use of very large doses of strychnine nitrate subcu. This case received a total of 6 grains in 10 days without any signs of twitching of the muscles.—*L. T. Brown, M.D., Boston.*

The Diagnosis, Prognosis, and Early Treatment of Poliomyelitis. Robert W. Lovett. *Jour. A. M. A.*, May 27, 1922, page 1607.

It is common knowledge that many cases of poliomyelitis are overlooked in the early stages, being incorrectly diagnosed as all sorts of febrile affections, and the diagnosis cleared up only after the paralysis develops. Also, typical cases may occasionally occur without any manifestation whatever of systemic disturbance in the way of fever, malaise, or respiratory or digestive upset. Laboratory diagnosis can be made in the early stages by spinal tapping. The cerebrospinal fluid is increased, clear, and a few polynuclear cells may be present (virus absent). At times experts are unable to differentiate the poliomyelitis from tuberculous meningitis by spinal tapping. The author points out that tenderness should at once arouse suspicion.

Dr. Lovett discusses the pathology and points out that initial changes occur around the blood-vessels of the spinal cord, where a marked infiltration takes place shutting off their supply of blood. Anemia or necrosis of the anterior horn cells may result. The whole effects of the condition are localized in the motor cells of the anterior horns of the spinal cord. The result then must be (1) a loss of power in the muscles supplied by the cells in question; (2) no loss in sensation because the cells in the posterior horns are not involved

in the process; (3) reflexes are lowered in the part involved. Thus the disease picks out motion alone and leaves sensation untouched. Drugs are of no value in the treatment. Keep the patient quiet mentally and physically. No stimulation; no massage; rest as long as tenderness is present. If there is extreme tenderness, allow the patient to lie in the position which is most comfortable. The outlook for recovery in the abdominal muscles is poor. The main treatment is to prevent deformity and restore function. The former is accomplished by means of posterior wire splints or posterior casts; the latter by massage and muscle training. Massage does not improve muscular power, but improves nutrition, circulation, and muscle tone. If the exercises are not carefully controlled, the patient is sure to use the strong muscles instead of the weak ones, to develop these, and thus to make the muscular balance still worse. Weight-bearing exercises, with casts or braces, such as walking to any extent in the first year after infantile paralysis, is apparently attended with risk and is followed in many instances by a change from partial to total paralysis.—*Voigt Mooney, M.D., Pittsburgh.*

Deltoid Paralysis and Arthrodesis of the Shoulder-Joint. George F. Straub. *Surg., Gyn., and Obstet.*, April, 1922, page 476.

Report of an operation for arthrodesis of the shoulder-joint for paralysis of the deltoid.

The main points of the operation are 1st, most thorough removal of synovialis; 2nd, most radical removal of all cartilage down to spongiosa; 3rd, strict avoidance of all foreign nonabsorbable fixation and suture material (he uses a tibial peg); 4th, the use for fixation purposes of the upper part of the biceps tendon which is put into the intertrochanteric groove, from which has been lifted up a shell of bone.

Immobilization in a plaster cast for 12 weeks. The position in which the arm is put is with the humerus at about right angle abduction to the body, viz., the external border of the scapula from 80 to 110 degrees to the axis of the humerus.

He shows pictures of one case 12 weeks after operation.—*L. T. Brown, M.D., Boston.*

FORMS OF ARTHRITIS.

Chronic Infectious Arthritis: Statistical Report with End-Results. Frank Billings, George H. Cole, and William S. Hibbs. *Journal A. M. A.*, April 15, 1922, page 1097.

A long article impossible to abstract. Certain points of interest may be mentioned.

The article is a report of the treatment of 411 patients with chronic arthritis. The writer says that a study of the group justifies the view that the morbid tissues, both hypertrophic or proliferative, and atrophic or degenerative, are secondary to the primary reactions of the joint tissues due to the presence of infectious invaders or their toxins. The embolic mode of infection is the cause of the tissue reactions. General chronic infectious myositis with but slight joint involvement in the early stage of the disease was a clinical entity in this group.

The statistics of the group showed that the more acute the onset of infectious arthritis, the more favorable the prognosis for improvement and cure, and the more insidious the onset, the less favorable the prognosis for improvement or cure. Of a group of patients admitted within two years of the onset of their disease, 133 in all, 42 recovered and 36 were improved. Of 278 with a period of more than two years, 29 were cured and 106 were improved.

The statistics confirm the opinion that specific remedies in the form of bacterial antigens are of little or no value.

In conclusion the writer says that "the clinical investigation confirms and substantiates the present point of view of a majority of clinicians who have had the opportunity to make a careful investigation of chronic deforming arthritis, that it is primarily an infectious disease and that the infectious microörganisms which are the cause are usually strains of nonhemolytic streptococci of relatively low virulence, or occasionally strains of nonpyogenic gonococci or even other bacteria of mild pathogenicity.—*L. T. Brown, M.D., Boston.*

Two Cases of Rheumatoid Arthritis. A. Mackenzie Forbes. *Canadian Med. Assoc. Journ.*, May, 1922.

The first patient was a woman 56 years old who had had recurring attacks of sciatica since she was twenty. She entered the hospital with the left hip held in flexion of 35 degrees and the right one in flexion of 45 degrees. The hips were held fixed, but not ankylosed. A diagnosis of rheumatoid arthritis was made and the tonsils considered the source of infection. After their removal local dry heat was applied to the hips, massage and manipulations used, magnesium sulphate and iodine given, and the patient at the end of six weeks was "greatly improved and discharged to her home where she could continue treatment."

The second patient was a woman 38 years old, with a similar condition of her hips. No sources of infection were found. In this the author followed out a suggestion made several years ago by Dr. Pemberton, that in many of these cases a decreased sugar tolerance appeared to be the cause of the arthritic symptoms. A biochemical examination was made establishing definite evidence of diminished sugar tolerance and the patient was put on a dietary with almost complete restriction of the intake of sugar and carbohydrates. An improvement took place, but albumen and casts appeared in the urine, that only cleared up after a return to a more normal diet. Further report is not given.—*C. A. Parker, M.D., Chicago.*

Amebiasis of the Bones. Charles A. Kofoid and Olive Swezey. *Journal A.M.A.*, May 27, 1922, page 1602.

The authors carefully discuss in detail their observations relative to the ameba in the lesions of Ely's non-bacterial or second type of arthritis deformans. They speak of the connection between infection by endameba dysenteriae and bone rheumatism. Many instances of coincidence of amebiasis and a diagnosis of arthritis have come to light in the course of more than 15,000 stool examina-

tions. On the basis of the type of mitosis and of the number of chromosomes in the cell, the ameboid organisms in the bone marrow are amebas rather than ameboid human cells. They appear in all respects to be normal amebas, and the mitosis to be normal type. There is no structural evidence connecting them with any form of degenerating human cells in the lesions examined. The authors conclude that Ely's second type of arthritis deformans is amebiasis of the bone. The authors studied sections of the head of the excised femur. They found in this material ameboid cells which they interpreted as endameba dysenteriae.—*Voight Mooney, M.D., Pittsburgh.*

OPERATIVE TREATMENT OF ARTHRITIS DEFORMANS. A. Wollenberg. *Zeitschr. f. Orthop. Chir.* B. XLII., 5. H., S. 275, 1922.

The author's observations are limited to the lower extremities, for which he gives the operative indications. Only cases of the Volkmann-Virchow types of arthritis deformans and not progressive polyarthritic and neuropathic arthritis deformans are considered.

I. For arthritis coxae the indications are: 1—persistent pain and discomfort notwithstanding prolonged conservative treatment, and 2—excessive loss of hip function, which greatly interferes with walking.

Cases with pseudo-ankylosis in poor position may well be corrected by subtrochanteric osteotomy; forcible correction may result in sad consequences and had better be avoided.

Whenever mild rocking motion exists, the intra-articular procedure is preferable because markedly limited motion, even with good position of the femur, is invariably painful. The intra-articular operation should aim to restore motion of the joint in patients not exceeding 50 years of age. The loss of the restored motion in the course of years may necessitate an ankylosing operation later if the patient is young enough, while in the old and decrepit, operative interference is contraindicated anyway, and the patient should be helped by a brace.

An unavoidable indication for an arthroplastic resection of at least one hip is given in cases of bilateral coxitis deformans with extreme loss of function.

II. The only indication for knee operations is a sudden and typical locking, incarceration, of the knee.

The operation should be incomplete, *i.e.*, neither arthrodesis nor arthroplastic resection, but should aim only to remove loose bodies and such as may be adherent to the synovial membrane or attached to the bone surfaces and thus cause symptoms.

III. Ankle-joints are operated upon as conservatively as the knees, but the results have not been favorable. After removal of loose bodies and chiseling off of osteophytes from the tibia and astragalus, only very little improvement has been gained; the author, therefore, advocates an ankylosing operation, arthrodesis of the ankle-joint.

IV. In the foot, arthritic lesions, which are very painful, may be found most frequently in the astragalo-scaphoid joint. Resection of the joint with the purpose of correction of the flatfoot position is advocated.

The metatarso-phalangeal joints may present osteophytic growths which are very incapacitating and painful. They should be restored to normal by means of chisel and file under local anaesthesia.

The exostoses of the os calcis are operated upon only when they cause unbearable pain and are not relieved by properly shaped arch supports.

No case of arthritis deformans should be submitted to operation before an extensive course of conservative therapy, motion without weight-bearing, local heat, and other physical agents, has been instituted and faithfully carried out. —*A. Gottlieb, M.D., Los Angeles, Calif.*

Contribution to the Study of Late Hereditary Syphilitic Osteo-Arthropathy of the Shoulder. Miginiac and Cadenat. *Revue d'Orthopédie*, March, 1922, page 105.

The joints do not seem to be so frequently affected by syphilis as the bones, and of all joints, the shoulder is most rarely affected, judging at least from the small number of cases reported in literature.

The authors report a case of a boy of 13 who began to have pain in the right shoulder in March, 1921, following a slight fever. He cried with the pain four or five days, then a tumor on the shoulder became apparent and within a month the pain was gone, but the tumor persisted. The swelling was rather hard and about the shape of a leg of mutton. The superficial veins were dilated, the skin was hot, there were some swollen glands under the clavicle and a large soft one in the axilla. The humeral head appeared to be enlarged and could be moved enough to produce an anterior luxation without causing any pain, but active motion was very difficult. The first thought one had from the clinical picture was of sarcoma, but the roentgenogram showed no such growth. Except for slight decalcification and elevation of the periosteum along the external aspect of the surgical neck, the humerus was normal. There was an upward displacement of the humeral head, the space between the glenoid and head being widened. By elimination a diagnosis of syphilis was made and confirmed by finding some of the classical signs of hereditary lues in other parts of the body and by a positive blood Wassermann in the child and in the mother. In May of the same year a point of fluctuation appeared over the biceps from which 2 cm. of yellowish fluid was evacuated. No bacteria were present in it, but the fluid gave a strong positive Wassermann test. The swelling was reduced under a course of neo-salvarsan and gray oil.

Eight similar cases were found in the search through 132 articles on luetic arthritis and a résumé of these is given. From these cases and that of the authors the principal characteristics of hereditary syphilis of the shoulder are summarized as follows:

1. There is never any suppuration nor are there sinuses, the clinical picture resembling sarcoma or tuberculosis.
2. Swollen glands in the neighborhood of the joint.
3. The roentgenogram is practically negative, sometimes showing a little periosteal elevation or rarefaction of the bone.
4. Pain is moderate or absent and passive motion is free, luxation being possible sometimes.

5. No definite tenderness on pressure, but diffuse, rather hard swelling.
6. No muscular contracture, no bony deformity, no general cachexia as in malignant growths.
7. Surgical treatment is useless if not disastrous. Amelioration is rapid under treatment with mercury or arseno-benzol preparations.—*William Arthur Clark, Pasadena, Calif.*

A Case of Arthritis Deformans Juvenilis of the Hip. Yvernault. *Revue d'Orthopédie.* March, 1922, page 140.

A typical case of Legg-Perthes disease of the hip is reported. The deformity was quite marked but presented no unusual departure from the characteristic flattening of the femoral head and the limitation of abduction and inward rotation.

The patient was 21 years old and had never suffered any pain in the hip, but had complained of his right knee and limped in the right leg. When seven years old he had sustained an injury to this knee which was followed by acute swelling and necessitated immobilization for two months. This, however, had left no impairment of the joint and had caused no further trouble until the present limp began.

The fact that the deformity in the hip developed with practically no symptoms leads the author to conclude that its origin was probably congenital.—*William Athur Clark, Pasadena, Calif.*

FRACTURES AND DISLOCATIONS.

Traumatology of the Carpus. A. H. Bizarro. *Surg., Gyn. and Obstet.*, May, 1922.

Bizarro presents a detailed study of 123 cases of carpal injury occurring in his own practice and in the records of the Royal Herbert Hospital.

The distribution of the fractures is shown in the accompanying table.

	Cases	Single Lesion Cases	Associated Lesion Cases
Radius	8	0	8
Ulna	7	0	7
Scaphoid	106	68	38
Semilunar	20	2	18
Cuneiform	3	0	3
Pisiform	1	0	1
Trapezium	2	0	2
Trapezoid	2	0	2
Os Magnum	15	6	9
Unciform	8	4	4
Metacarpals	3	0	3

The mechanism of 55 scaphoid fractures without extrinsic synostosis is given as follows:

	Cases
Fall on the hand	41
Fall on the thumb	1
Sprain	4
Backfire of motors	3
Crushed wrist	2
Fall of weight on wrist	2
Boxing punch on wrist	2
	55

Diagrammatic profiles of the individual cases are given, with a discussion of the morphology of the carpal bones and the physiopathology of their fractures.

Treatment. "The upper carpal lesions usually require rest and the lower ones early movement."

Dislocations should be reduced when possible—in early cases—preferably under anaesthesia, and in case of scaphoid fracture rest maintained for four weeks. He advises plaster of Paris, with a change in two weeks to overcome the looseness from the shrinking of the tissues. The thumb should be included. Fragments that cannot be replaced should be removed, the semilunar through a palmar incision, and a lateral incision for the scaphoid. In extensive injuries he favors extensive removal, with early mobilization of the parts.

The fragments of the navicular seldom unite. "However, any of the above conditions, if seen early and early treated, usually lead to no disability at all."—*C. A. Parker, M. D., Chicago.*

METATARSOPHALANGEAL FRACTURES: REPORT OF TWENTY-SEVEN CASES. A. G. Bolduc. *Jour. of Indust. Hygiene,* April, 1922.

The writer advises an x-ray in all cases of injury of the foot or toes because it is his experience that the so-called contusion is very commonly a fracture.

The most common fracture in his series of 27 cases was the chip fracture, a simple or compound fracture of the distal phalanx. Next comes fracture of the proximal phalanx, and last the metatarsal.

The most common symptoms are continuous throbbing pain, tenderness to pressure, swelling, and, in some cases, localized oedema.

Treatment of chip fracture is always surgical, requiring an incision on the lateral side of the phalanx to relieve the tension of the extravasated blood in the encapsulated sac in the end of the toe.

Conservative treatment in phalanx is best. The disability period in these cases averaged 20 days, the longest being 38 days—6 cases.

Conservative treatment again in a plaster cast for metatarsal fracture is best. The period of wearing the cast is three weeks, but the disability extends about a week or two longer.—*L. T. Brown, M.D., Boston.*

PATHOLOGICAL FRACTURES.. E. A. Codman. *Surg., Gyn. and Obstet.,* May, 1922.

This is a so-called "10-minute résumé" of this very interesting chapter in surgery. Dr. Codman outlines it under ten headings.

1. The literature,—referring to Eisendrath, in Keen's Surgery and the Registry of Bone Sarcoma.

2. Etiology. As secondary causes almost every human activity is mentioned, but he does not attempt to name them.

3. Pathology. Refers to Eisendrath's table:

   1. Fractures resulting from bone fragility of local origin, tumors, cysts, etc.
   2. Fractures resulting from bone fragility due to some general disease, neuropathies, senile changes, scurvy, etc.
   3. Fractures resulting from idiopathic fragility of bone (osteoporosis fragilitas ossium).

4. The pathology of bone tumors. In the absence of a standard nomenclature he groups them under the following headings:

   Osteitis fibrosa.
   Bloodgood's giant-celled tumor.
   Giant-cell sarcoma.
   True osteogenic sarcoma.
   Metastatic growths.
   Multiple myeloma.
   Tumors of tissues which normally occur in bones as well as in other parts of the body.
   Chondroma.
   Osteoma.
   Rare tumors.
   Tuberculosis, etc.

5. Differential diagnosis. He feels that exploratory incision should be the rule and that in the majority of cases, with proper sections, clinical history, and x-rays, an expert pathologist can make a differential diagnosis. A few border-line cases will still puzzle him.

6. Prognosis. With the exception of those caused by new growths it is a rule that pathological fractures tend to unite without much delay: with tumors and metastases they rarely unite.

7. Treatment. "The treatment is the appropriate treatment of the lesion which has weakened the bone. Exploratory incision and expert pathological opinion are the first steps."

8. Prophylaxis. It should be a general rule to splint all tumors of the large bones, especially the femur and the humerus, when tumors are found, until the tumor is otherwise disposed of. Ewing has long felt that every sarcoma of a large bone should be splintered and the patient kept in bed on account of the danger of metastases.

9. Theory. Codman raises the question whether fractures ever cause sarcoma, whether the granulating elements may not sometimes be set loose and lose their normal restraint limited to the formation of new bone. He leaves the question open.

10. Research. At present the so-called giant-celled tumors particularly are occupying the attention of the pathologists. In closing he makes a plea for the use of the Registry of Bone Sarcoma in registering every case that comes to the knowledge of the profession.—*C. A. Parker, M.D., Chicago.*

MECHANICS AND TREATMENT OF FRACTURES OF THE FOREARM. Paul B. Magnuson. *Journal A. M. A.*, March 18, 1922, page 789.

The writer points out the fact that in fractures of the Colles type and the chauffeur's type the injury that is done to the joint lies between the lower end of the radius and the ulna and the ligaments and fibro-cartilaginous substance which make up this joint. Lack of attention to this often results in lack of supination.

Fractures of one or both bones of the forearm above the wrist may be treated in semipronation or full supination as the two bones are at their maximum distance apart in either of these positions.

Fractures of the forearm must be classified according to their relation to the insertion of the pronator radii teres. Fractures above this insertion, because of the diverse muscular pulls and the fact that the nutrient artery may have been injured, causing extra hemorrhage and more danger of synostosis, should be treated surgically, as mechanical methods are less likely to give good results.

Fracture of the ulna above the middle is the result of direct violence and is often associated with dislocation of the head of the radius. The loss of the carrying angle caused by this fracture is very serious as regards function.

Treatment: non-operative ambulatory, which the writer believes is the cause of many of the bad results in forearm fractures; non-operative ambulatory and operative. Traction is best accomplished by being in bed with suspension of the forearm in a perpendicular position and the elbow flexed at right angles. Extension must not pinch the radius and ulna together. The finger and thumb must be free at all times. Pronation and supination should be under the control of the surgeon and not of the patient.

In the operative treatment the writer believes that lateral incisions are best as they involve no nerves, vessels, or tendons, which lead to adhesions. Ivory plates or screws are the best. The fingers and hand should be moved at the earliest possible opportunity.—*L. T. Brown, M.D., Boston.*

OPERATION FOR COMPLETE, IRREDUCIBLE, CONGENITAL DISLOCATION OF PATELLAE. Albert Mouchet and Jacques Durand. *Jour. de Chirurgie,* Sept., 1921.

Report of a case of this rare condition. Boy, seen at age of 10 years. Condition bilateral; no abnormality noted until he began to walk, at 16 months. No locomotor difficulty, except on stairs, to age of 6 years; since then walked with increasing difficulty, and with pain at knees. Seen by authors at age of 10 years. Patella of each knee very small, lying over external surface of external condyle, in plane at right angles with normal position; irreducible, but freely movable. Tibial tubercles displaced well to outer side of normal site. Free passive motion at knees, with even more than normal flexion; some loss of active extension. Positive Wassermann test.

Operation consisted in freeing a tongue containing the patella, its quadriceps and patellar ligaments and the detached tubercle; then passing tongue through a buttonhole in upper aspect of joint capsule. The detached structures thus fall into normal line where they are retained by sutures; tubercle is fixed by screw to new site on tibia; area denuded by dissection of tongue is covered by approx-

imation of margins; semilunar skin incision closed. Immobilization in plaster for 40 days. Walking permitted after 2 months. Functional result very satisfactory in both knees; walking much improved. Flexion of knees regained slowly; at end of 12 months could flex only to right angle on one side, better on other side.—*Roades Fayerweather, M.D., Baltimore, Md.*

THE TREATMENT OF RECENT FRACTURES. **Frank E.** Peckham. *Amer. Jour. of Elec. and Radiology*, June, 1922.

The author says that fractures must be considered primarily from a mechanical viewpoint and that if surgery should be found necessary in any case that it must be used as an aid to mechanics. Instead of forcible manipulation to reduce fractures, which often fails and gives the excuse for unwise open surgery, he employs mechanical appliances which act as both the reducing and the permanent holding mechanism. He makes frequent radiograms to show position of fragments and progress of union. In fractures of the surgical neck of humerus he employs traction and countertraction by a splint which holds the flexed forearm pointing straight forward and the arm by the side. Movements and other physiotherapy are begun as soon as union will permit. In fractures of the femoral neck he uses the usual weight and pulley extension on leg with counter-extension by another weight and pulley attached to a perineal strap. When the limb is pulled down to normal position after a few days he adds internal rotation of limb by adhesive straps and a T splint. No weight-bearing until sixth or seventh month.—*R. W. Billington, M.D., Nashville.*

OPERATIVE TREATMENT OF CERTAIN FRACTURES OF FEMUR, HUMERUS, AND FOREARM. E. W. Ryerson, *Southern Med. Jour.*, June, 1922.

The author uses Whitman's method for fresh fractures of neck of femur and the bone peg for ununited cases, exposing fully and freshening ends of fragments. Fractures of shaft of femur are treated by Thomas splint and Balkan frame. Open operation is rarely required, but more often in transverse than oblique fractures. He uses a short intramedullary peg of beef bone to prevent lateral displacement and maintains alignment by the Thomas splint. Autogenous graft is used in ununited cases. He also uses the intramedullary beef-bone peg frequently in fracture of both bones of forearm, many of which cannot be held in good position by external splints. He believes that very few open operations on fractures are required if the surgeon knows how to use and has the proper kind of external appliances; that very few communities are at present equipped with the essentials for proper handling of fractures, and that disabling fractures of the femur and other important bones should be as well treated as are diphtheria and appendicitis.—*R. W. Billington, M.D., Nashville.*

PHYSIOTHERAPY IN THE AFTER-CARE OF FRACTURES. H. E. Stewart, *Amer. Jour. of Electrother. and Rad.*, June, 1922.

The careful application of physiotherapy, chiefly the various forms of heat and manipulation, aid markedly in the early return to function in the cases of simple fracture. In complicated fractures other types, such as ultra-violet

ray to sinuses, ionization of scar tissue, sinusoidal current to restore muscle tone, etc., are helpful when properly applied. No surgeon can afford not to employ these measures. They are to be used as an aid to, and not a substitute for, surgery.—*R. W. Billington, M.D., Nashville.*

OTHER TRAUMATA.

A CASE OF TRAUMATIC MYOSITIS OSSIFICANS. S. L. Bhatia, *Indian Medical Gazette*, March, 1922.

The author describes a case of traumatic myositis ossificans occurring in a soldier twenty-four years of age, in the Indian service, treated at the Indian General Hospital, at Bombay.

The patient was kicked by a horse in the left thigh, with resulting huge painful swelling, which after two months gradually tended to lessen in size, but continued to cause a limp and dull aching pain when walking.

The x-ray examination showed a large, irregular bony mass which seemed to be periosseous and apparently arose from an old hemorrhage affecting the quadriceps extensor muscle, associated with stripping of the periosteum and liberation of osteoblasts, with resulting new bone formation. The treatment was entirely palliative; ossification had become complete in two and one-half months. Because of the slow progress and slight disability, surgery was not urged. However, should the tumor increase in size later, the author would suggest excision of the entire tumor, together with some of the surrounding muscles, so as to be sure of excising all of the bone-forming foci.—*H. W. Meyerding, M.D., Rochester, Minn.*

TENNIS ELBOW. L. Cooke, *Indian Medical Gazette*, April, 1922.

The author discusses briefly the causes of tennis leg, cricket leg and rider's muscle and so-called foot-ball leg, and compares the findings of tennis elbow with the above. Generally speaking, these conditions are caused by a rupture of weakened muscles when put to unusual strain.

In tennis elbow the rupture of the supinator longus muscle is the probable cause of the disability. The fibrosis, periostitis, and proximity of the muscles with nerve results in considerable pain. The author advises against rest. However, he believes in adhesive strapping, massage, and "carrying on"; even moderate tennis is allowed. The strapping or bandaging about the elbow prevents undue movement at the elbow and allows the player to use the arm, playing principally from the shoulder. He recommends adhesive strapping from the outer surface of the arm from the external condyle nearly half way up the arm. (These straps should encircle only half the circumference of the arm, and one should overlap the other. The centre of each piece of strapping should be over the external supra-condyloid ridge.) Following the play the strapping is removed and heat is applied, followed by massage.—*H. W. Meyerding, M.D., Rochester, Minn.*

THE DIAGNOSIS AND TREATMENT OF SOME COMMON INJURIES OF THE SHOULDER JOINT. Robert W. Lovett, *Surg., Gyn., and Obstet.*, April, 1922, page 437.

This paper was read before the Chicago Surgical Society. It gives the anatomy of the shoulder-joint and the actions.

Under diagnosis it speaks of the importance of recognizing the difference between sprains of the ligaments, muscular strains, injury to the biceps tendon, synovitis, rupture of the supraspinatus tendon, and bursitis of the various bursae above the joint.

Under treatment, Dr. Lovett advises use of the platform splint in order to get abduction of the arm, which is essential in all cases of injury of the shoulder-joint. For adhesions he does not believe that massage or nagging, passive movements are advisable, as they are painful. Gradual abduction of the arm up to the point of pain is the best method. Occasionally abduction under an anaesthetic for a special block of the abduction may be necessary.

For supraspinatus tendon rupture, the sabre cut incision of Jones is best. The other condition demanding operation is chronic bursitis of the subdeltoid bursa which has not yielded to conservative measures, and also where there is calcification of the walls of the bursa.

He describes a condition which he calls irritable arm or false neuritis, which occurs in nervous, overworked women, which has symptoms wholly out of proportion to the cause. For treatment a sling and the gentlest possible massage and radiant heat.

(He makes no reference to the fact that a forward rounded shoulder is a potential of strain to the ligaments and capsule, and may keep up and even make worse a slight injury.)—*L. T. Brown, M.D., Boston.*

TRAUMATIC OSTEITIS OF THE WRIST. By Mark H. Rogers, M.D., *Boston Medical and Surgical Journal*, June 1, 1922.

Dr. Rogers has given us a clear and concise description of a bony lesion of which there is slight mention in literature.

There is pain, swelling, and disability, especially in dorsiflexion, which is chronic, and may or may not follow a history of injury. The symptoms subside with rest and immediately return when the wrist is used again. The x-ray shows a picture similar to tuberculosis of the semi-lunar or scaphoid bones, or may show a rarefied or shrunken condition.

He reports 4 cases, in all of which the bone was removed and a careful pathological examination made. No evidence of tuberculosis or other inflammatory condition could be found, but the cortex was thinned and much more fat and less osseous tissue than normal was present in the interior of the bone.

Function was perfect in one case, but not as good as before operation in others, and the symptoms had disappeared.

The paper is illustrated by 4 skiagraphic reproductions.—*H. A. Pingree, M.D., Portland, Maine.*

FRACTURE IN OSTEITIS DEFORMANS. By J. Anderson Smith, *British Med. Journal*, May 27, 1922.

The author reports a patient, aged fifty-one, with well-marked osteitis defor

mans, who slipped and fell over a cane, fracturing the upper tibia. The line of fracture was clear-cut, just as if done by a osteotome, and after apparent union in three weeks, the limb again gave way. Consultation was held after several weeks for delayed union, and amputation was considered. However, upon further consultation, prolonged fixation was advised and union occurred with stiffness of the knee. The patient also had retinitis pigmentosa and extensive psoriasis.—*H. W. Meyerding, M.D., Rochester, Minn.*

EPICONDYLITIS OF ATHLETES. Tavernier. *Revue d'Orthopédie*, January, 1922, page 5.

This lesion is characterized by persistent pain over the epicondyle of the humerus coming on after violent exercise of the arm. It is especially frequent in tennis players and in fencing masters.

The first publication on the subject was in 1896 by Bernhardt of Berlin, but it seems to have been forgotten for about ten years thereafter. Since about 1909 many cases have been reported. The author reports his own personal experience with the lesion. It began in June, 1920, with pain around the epicondyle of the right elbow. He was able to play tennis, but the trouble was worse after every game. In August it became so severe that the game had to be given up. There was never any swelling or ecchymosis. Complete extension of the forearm, of the hand and of the fingers caused severe pain. Reverse strokes in tennis, passes to the left in fencing, suturing skin with a Reverdin needle, and, in fact, all attempts at supination of the forearm brought out the symptoms very sharply. In September it was necessary to take a complete rest. All athletic games had to be given up, and it was not until January that the symptoms had practically disappeared.

The lesion is one of middle age, the statistics of Desplats showing 34 cases between 30 and 50 years of age, 11 over 50, and only 2 under 30. Those who are muscular and who play the game hard are most frequently affected. The symptoms are almost wholly subjective, the intensity of the pain being out of all proportion to the physical findings. It is not a spontaneous pain, but occurs only on motion or pressure over the epicondyle where the extensor communis digitorum takes its origin. Acute attacks usually subside with a week or two of rest, but the symptoms recur as soon as the exercise which causes them is resumed. The trouble may come and go in this manner for months or years and champions at tennis or fencing frequently have to give up because of it.

The pathology has been variously designated as rupture of tendon, abnormal relation of the radial head to the epicondyle, osteitis, and periostitis. Most of the observers who have written on the subject favor the idea that it is periostitis or an osteo-periostitis. Spurs and spicules on the epicondyle, and proliferation of the periosteum, have been demonstrated.

Diagnosis is usually simple and is made on the history and the characteristic localization of pain.

Rest is practically the only treatment necessary, but it must be prolonged many weeks after all symptoms have disappeared.—*William Arthur Clark, Pasadena.*

TUBERCULOSIS.

Hysterical Pott's Disease; Some Remarks on Diagnosis of Pott's Disease. Feutelais. *Revue d'Orthopédie*, January, 1922, page 37.

Several cases are reported to show that one or more of the classical symptoms may be absent in tuberculosis of the spine, and on the other hand the patient may present many typical symptoms of this disease but not have it at all.

The case which turned out to be hysteria was that of a girl of 18. Following an attack of the grippe in March, 1920, she had pain in the back and her physician noticed a fluctuant mass near the middle of the spine, which disappeared in a few days. The pain in the back persisted until she suffered almost continually. It was much less on lying down, but became worse again with movement. A kyphosis, slight but decided, was present from the twelfth dorsal to the second lumbar. The spine was tender throughout its entire length, but there was practically normal movement and the roentgenogram showed no lesion. In June there appeared a motor paralysis of the left leg and the patient had a violent nervous crisis which was strongly suggestive of hysteria. It was thought best to continue immobilization in plaster jackets, but just after a new cast was applied the patient had another very violent convulsive attack accompanied by cries and incoördinate movement. Finally the cast was removed, against the wishes of the patient, and she was given hydrotherapy on advice of a neurologist. In a few weeks she was completely cured of all symptoms.

Another case (boy of 7) showed a voluminous abscess in the left inguinal region, without pain, which on puncture yielded the characteristic creamy pus, and appeared to be a psoas abscess. However, there was no kyphosis, roentgenogram of the spine was negative, and movement in the back normal.

Five months later the abscess recurred and ruptured spontaneously, but there were no spinal symptoms. When seen a year later the child was completely cured and stated that the abscess had disappeared about eight months previous.

A case illustrating Pott's disease without any painful symptoms was that of a girl of 7, who had a kyphosis in the spine, muscular spasm of the vertebral column, and the characteristic lesion as demonstrated by the roentgenogram. In spite of all this, the child never complained of pain.

Another patient, 28 years old, after suffering several years with pain in the back and legs, finally developed a complete paraplegia. This disappeared after 14 months of immobilization. In spite of the facts that the roentgenograms were negative and the spine showed no kyphosis, this was regarded as a case of Pott's disease because no other disease could be demonstrated and the symptoms yielded to simple immobilization without any medication. — *William Arthur Clark, Pasadena, Calif.*

METABOLIC LESIONS.

Osteitis Fibrosa of the Os Calcis as a Cause of Typical Calcaneitis. H. J. Bettman, *Zeitschr. f. Orthop. Chir.*, B. XLII., H. 5., S. 309.

The case reported is the only one appearing in the literature.

CASE: Girl of 18, in perfect health, complained of pain on the entire calcaneus on pressure and when weight-bearing. No abnormalities on the skeleton: even very little on the affected os calcis, except a slight thickening, apparently the result of a previously attempted, but unsuccessful, operation. The radiograph is typical of an osteitis fibrosa (print accompanies article). The unsuccessful treatment consisted in some form of surgical procedure, the details of which could not be obtained by the author, and in the application of a brace and shoe, both of which were to guard against weight-bearing pain, but which were not efficient.

The patient has not submitted to either operative or conservative treatment, so that the fate of this rare and interesting pathological condition cannot be traced.—*A. Gottlieb, M.D., Los Angeles, Calif.*

COXA VARA. René Bloch, *Jour. de Chirurgie,* July, 1921.

This is the second article in a contribution entitled "Fractures of the Neck of the femur and Coxa Vara in Infancy and Youth." The author discourses on various aspects of the subject, illustrating his remarks with reports of numerous case records, culled from medical literature and unreported cases. Nothing essentially new is added to our knowledge of the subject. The feature of the article is the inclusion of numerous, semi-schematic x-ray tracings, based on the study of which the author recognizes three anatomical types of the deformity, and points out the possibility of diagnostic errors in misinterpreting certain appearances that resemble fracture of the neck. The division into types is according to that portion of the femoral neck in which the downward incurvation has originated: juxta-trochanteric, when situated at the origin of the neck; medio-cervical, when at the mid-region; juxta-capital, when at the junction of neck and head. In the medio-cervical type sufficient atrophy of the neck may have occurred to give the x-ray appearance of an apparent solution of the continuity, but the condition is to be distinguished from a fracture of the neck by the absence of any relative displacement of the two halves of the neck. Pathological fractures do sometimes occur where there has been a pre-existing coxa vara, and are to be recognized as such by the incurvation of the two fragments plus the loss of alignment. In the juxta-capital type the condition may be mistaken for separation of the epiphysis. With respect to etiology, prolonged, or "late," rickets is believed by the author to best explain the cause of the deformity. In its incipience, recumbency with continuous extension is recommended; in the confirmed cases, correction by subtrochanteric osteotomy. —*Roades Fayerweather, M.D., Baltimore.*

THE HUMORAL SYNDROME OF GOUT. A. Chauffard, *Brit. Med. Jour.,* May 13, 1922.

This is one of a series of exchange lectures between the Faculty of Medicine of Paris and the University of London. The Folin and Denis method for determining uric acid in blood has been modified by A. Grigaut and the normal figure of uric acid was found by Grigaut and the author to vary between 40 and 50 milligrams per liter of serum; hyperuricemia commences above this. In 27 cases of gout, the average of all figures obtained was 0.094 gm. Experiments designed to clarify the rôle of the liver in retaining uric acid brought

to it by the portal blood consisted of parallel analyses of portal and hepatic blood. In a series of observations on dogs receiving diets rich in nucleic acid, the proportion of the uric acid of the portal blood arrested by the liver averaged 33 per cent. In the fasting state and on a milk diet no difference was found between the afferent and efferent liver blood. A uricolytic insufficiency of the liver appears to be one of the most important factors in the production of exogenous hyperuricemia.

Hypercholestrinemia was found to accompany hyperuricemia in the 26 cases of gout studied by the author with F. Brodin and A. Grigaut. The average cholestrinemia determined was 2.25 grams per liter, while the physiological average is given as 1.70. It is thought that the excess of cholestrin is attributable to the liver. The coagulum obtained by the action of trichloracetic acid on serum often shows, after standing, a blue coloration indicative of excess bilirubin. The double evidence, hypercholestrinemia and hyperbilirubinemia, is evidence of the insufficiency of the hepatic functions in gout.

In gouty tophi, deposits of cholestrin occur together with those of uric acid. In a tophus of the heel, 8.5 per cent. of uric acid and 2.1 per cent. of cholestrin were found. The acute crisis of gout is considered analogous to acute attacks of asthma, urticaria and migraine, *i. e.*, a local serologic shock of an anaphylactic nature. Hyperuricemia is taken to be the potential exciting cause for this, capable under the action of a provocative agent such as errors of diet, dampness or cold, to provoke the local or elective shock, active local vascular dilation, painful reaction of sensory nerves, and local precipitation of sodium urate in the region of the inflamed joint.—*R. M. Wilder, M.D., Rochester, Minn.*

EXPERIMENTAL RICKETS IN RATS. V. Korenchevsky, *N. Y. Med. Jour. and Med. Record*, May 17, 1922, page 612.

The writer says that he and others have produced experimentally typical rickets or osteomalacia in different ways. He asks, do these results solve the problem of rickets? He says, certainly not. It is necessary first to prove that all of these play a rôle in the etiology of human rickets. The experimental results serve only to indicate some of the possible ways in which the problem might be solved. He says his experiments have shown that the Vitamin A deficiency alone is capable of causing rickets. They also indicate the importance of calcium deficiency, especially in combination with deficiency of Vitamin A.

He says that up to the present time there have been too few attempts to treat rickets by the administration of a combination of lime salts with Vitamin A, and perhaps oral administration is unsuitable on account of the production of calcium soaps. Hence he suggests that subcutaneous injections may give interesting results.—*L. T. Brown, M.D., Boston.*

OSTEOCHONDRITIS DEFORMANS JUVENILIS OF HIP. Lance, Andrieu and Cappelle, *Jour. de Chirurgie*, November, 1921.

The subject is dealt with under two captions: (1) Evolution and late results. (2) Relation to hereditary syphilis.

Remarking that certain writers state that Legg's disease sometimes or generally induces coxa vara in adolescence, others that it is the origin of osteoarthritis in adults, the authors sought to investigate the late results in their own cases. Of these they could collect but 5 for examination. The onset in the earliest case dated back 14 years; in the latest case, 7 years. All had received appropriate treatment during the juvenile, active period, but with interruption in two cases; the other three had been given extreme care. Upon reëxamination at this later date all five cases were found to present, in varying degrees, similar clinical as well as anatomical abnormalities, with marked deformations of the hip, the whole conforming to a recognizable type, characterized as follows:—

Anatomically: (1) A flattening and spreading-out of the entire epiphysis of the head, as though, in a softened state, it had been uniformly mushroomed down over the thickened, but otherwise unaltered, neck, enveloping the upper portion of the neck just as a Basque *beret* (sort of Tam o' Shanter) pulled down to one's ears. This is demonstrated in the lateral x-ray views; (2) direction of neck is unaltered; no coxa vara; (3) the superior aspect of the head has been levelled to a horizontal plane; (4) acetabulum deepened, and flattened in roof, in conformity to altered head; (5) some deformation of pelvis. These appearances are well shown in the semi-schematic x-ray tracings.

Clinically: All five cases limped, as result of varying limitations of motion, slight shortening, and muscular atrophy. All, in varying degree, had experienced recurring attacks of joint pain.

The authors conclude that Legg's disease is not to be interpreted, however, as a juvenile form of osteoarthritis deformans; it presents essential differences from the latter. They believe, on the other hand, that it does, like some other juvenile hip conditions, frequently provoke, later on, osteoarthritis of a certain type. Attempting to confirm their belief that this type is recognizable, *per se*, they report here 6 cases of osteoarthritis of the hip encountered in examination of candidates for reclassification in the French army. In clinical aspects, and in x-ray appearances, these joints conformed to the type above described. (The tracings of these joints are reproduced in this article, and resemble in a striking way the tracings of the late results in the authors' 5 cases.) Inquiry into the past history of these soldiers indicated that all had had childhood hip affections very suggestive of Legg's disease.

The second division of this article is concerned with a discussion of the resemblance of the early lesions in Legg's disease and the hip manifestations of inherited syphilis. Though far from convincing, this argument is interesting and demands consideration. The authors, themselves, venture only the conclusion that certain cases may have their origin in inherited syphilis. In this connection reports are included of 5 cases of hip affections, diagnosed as hereditary syphilitic, in children from Ombrédanne's clinic. Actual proof of syphilis was obtained in but two of these cases, but in all five anti-syphilitic treatment was followed by a rapid cessation of clinical signs and symptoms, with restoration to more or less normal x-ray appearances. This, of course, is in marked contrast with the evolution of Legg's disease, as heretofore observed. The reader naturally suspects that in spite of general similarities this group of five cases may have been wrongly identified with Legg's disease; yet he may do well to agree with the authors that, as yet, one cannot entirely reject

the possible identity of the two conditions. It appears from reports of their observations that the final prognosis in Legg's disease cannot include always a *restitutio ad integrum*, and may, indeed, require serious reservations. This prognosis would be improved greatly if it could be shown that syphilis was the origin of the hip disturbance. In any doubtful case the therapeutic test is certainly indicated.

In spite of its lack of finality, this article is worthy of attention, both by reason of its report of late results in treated juvenile cases, and also for its comparative study of anatomic deformations.—*Roades Fayerweather, M.D., Baltimore, Md.*

GROWTH PROBLEMS FOLLOWING OSTEOMYELITIS OF ADOLESCENT LONG BONES. Kellogg Speed. *Surg., Gyn., and Obstet.*, April, 1922, page 469.

An interesting paper discussing the problem of what to do when from osteomyelitis there has been an impairment of the growth of one epiphysis, as, for example, in the lower leg with the resultant deformity which comes as the uninjured part continues to grow. For treatment of this he has adopted the following rules:

I. Remember the law of nutrient arteries in relation to growing long bones, *i.e.*, the nutrient arteries are directed toward the elbow and from the knee, and the epiphysis toward which the artery is directed unites first. The fibula is an exception, of course. Consequently the lower end of the femur, the upper epiphysis of the tibia, the lower epiphysis of the radius and ulua, and the upper epiphysis of the humerus all unite last in their respective bones and must be the most guarded.

II. Unless a bowing deformity in the leg or forearm tends to manifest itself rapidly and to cause great loss of function or threaten skin necrosis, splint correction of the extremity for at least a year is favored.

III. If both clinical and x-ray examination during the course of the year show that the bone is arrested in growth, a shaft resection of the companion bone remote from the epiphysis is performed to equalize the length. Simple means (kangaroo tendon) of holding the resected ends in apposition are used, followed by a firm splint until union takes place.

IV. If the child is young (many years and inches of growth expected) after 2 or 3 years when it is quite positively established that the epiphysis of the damaged bone has ceased all growth and is obliterated, the analogous epiphysis of the fellow bone may be excised (epiphysectomy) to stop its overgrowth. Each bone then grows at an equal rate from the remaining epiphysis and there is no fear of subsequently appearing bowing deformity. Length deformity will persist.—*L. T. Brown, M.D., Boston.*

MISCELLANEOUS.

OPERATIVE TREATMENT OF TUBERCULOUS SPONDYLITIS. Bachlaender. Beitr. z. klin. *Chir.*, Bd. 124, H. 3, p. 655.

In regard to the question of judgment as to whether ankylosis of the vertebrae by means of a bone graft should be done for tuberculosis, there are cases of importance which by autopsies furnish the end-results of the transplant. Up to now there have been two cases of Meyer from Biesalski's clinic and one case

of Görres, examination of which showed absolutely firm bony union between transplant and spinous processes.

The author now reports the case of a patient who died eight weeks after operation. The surface of the transplant, although not covered with periosteum, was firmly united by bony growth with the spinous processes, while the periosteal side of the grafts was not yet firmly united even on the free border. It was, nevertheless, impossible to loosen the transplant from its union with the spinous processes. In forward and backward bending motions the transplant proved to be an absolute entity with the vertebral bodies. On the other hand, however, rotation was present in the lower parts which might easily lead to a fracture of the transplant. The author draws the lesson from this that rotation movements must be avoided and that a corset cannot hinder rotation.—*Armin Klein, M.D., Boston.*

End-Results of Operation for Dupuytren's Contracture. Dr. A. Bruce Gill, *Annals of Surgery*, April, 1922, p. 504.

Dr. Gill, who reported a method of operation for contracture of the palmar fascia in the *Annals of Surgery* for August, 1919, now presents the end-results three years later. These are said to be excellent, with no return to the contractures and with little or no finger stiffness, the latter being largely caused by the prolonged splinting which follows the usual operation by tenotomies. His operation involves the complete excision of the contracted palmar fascia and its replacement by a free fat transplant from the thigh.—*J. A. Nutter, M.D., Montreal.*

Treatment of So-Called Sciatica. J. A. Nutter, *Canadian Med. Assoc. Journ.*, May, 1922.

Nutter says that the large number of patients afflicted with leg pains and pains in the distribution of the sciatic nerve coming of late to the Montreal General Hospital has given him special opportunity to study the causes and treatment of these distressing conditions. The conception of Gowers that practically every case of sciatica is a true neuritis, he says, is being superseded by the belief that most instances of sciatica are really those of referred pain, especially from the neighboring joints, the lumbosacral, sacroiliac and the hip-joints named in the decreasing order of their frequency as offenders. He considers that 80 to 90 per cent. of cases are those of referred pain.

The treatment is medical and mechanical, the former being directed to the eradication of sources of infection, the regulation of the diet with low protein content, the giving of salines, and the local application of heat with massage. For sacroiliac strain he advocates the use of a flannelette spica made to bind the pelvis and hips very tightly together. In women a special corset with tight lacing over this region is recommended. Other measures, such as fixation of the hip-joint in plaster or otherwise, are used when this region is considered the source of the trouble. Nutter is probably right, that a large proportion of these typical joint pains are called sciatica, but we cannot believe they are often so considered by careful diagnosticians.—*C. A. Parker, M.D., Chicago.*

CHANGES IN FINGER NAILS AFTER RHEUMATIC FEVER AND TUBERCULOSIS. William H. Rosenau, *Jour. A. M. A.*, June 10, 1922, p. 1783.

Dr. Rosenau gives an interesting discussion of his observations at Johns Hopkins and Pirquet Kinder-Klinik in Vienna, relative to changes in finger nails after rheumatic fever and tuberculosis. His findings, in brief, are given in the following: (1) Small, circumscript depressions (pocking, stippling) occur in the nails following acute rheumatic fever and chorea in approximately 95 per cent. of the cases, particularly when heart complications are present. These changes are temporary and may disappear, to reappear after a recurrence of the same disease or some other infectious disease. One may see these changes as late as fifteen years after the last attack of rheumatic fever. These changes do not appear, as a rule, before six weeks have elapsed after the patient is taken ill, and often appear at a later date. The earliest time of their appearance is five weeks. These depressions are not infrequently associated with horizontal furrows, most often incomplete, and are not uncommonly seen together with lengthwise furrows, complete and incomplete. These changes, occurring in the absence of active tuberculous disease, and with an associated heart lesion, are confirmatory, though not definite evidence, that the patient has passed through an attack of acute rheumatic fever or chorea, and that a heart lesion if present, is probably rheumatic in origin. (2) These changes also occur in active tuberculosis in 70 per cent. of the cases, but they are often associated with transverse and longitudinal grooves and clubbing of the finger nails. (3) The depressions have been found in 4.5 per cent. of control cases in which no definite etiology could be ascertained, and they have also been found occasionally after a variety of diseases, such as scarlet fever, smallpox, empyema, typhoid, and Hodgkin's disease.

The author points out that the nail grows at the rate of .1 mm. per day. The nail completely recovers itself in 80 to 90 days in children, and in 120 to 132 days in adults.—*Voigt Mooney, M.D., Pittsburgh.*

INTERMITTENT CLAUDICATION DUE TO CARDIAC HYPOPLASIA. Serko, *Wiener Klin. Woch.*, Feb. 2, 1922.

A 13-year-old boy, negative history in infancy, started to walk at the age of two years, and then walked with difficulty because of apparent fatigue. As the child grew older, he became more abnormally exhausted and could walk only a few steps without collapsing. On examination cardiac action was found to be accelerated (120), and on ten knee bendings, 160.

The radiograph showed an unusually small heart with a narrow aorta. A radiograph of a normal 8-year-old boy showed the heart to be about one-third larger than that of the patient.

There is no doubt that the congenital narrowing of the vascular system and the hypoplasia of the heart were the causes of the intermittent claudication in this case.—*Armin Klein, M.D., Boston.*

REPORT OF PROGRESS IN ORTHOPAEDIC SURGERY. M. N. Smith-Petersen, M.D., *Boston Medical and Surgical Journal*, May 18, 1922.

Dr. Smith-Petersen has taken as his subject the "Report of Progress in Orthopaedic Surgery" as published in the *Archives of Surgery*, January, 1922. The author has given such a concise and matter-of-fact review that an abstract here seems useless and the reader is referred to the original paper. Its conservatism and brevity are to be commended and it covers pretty thoroughly the whole field of orthopaedics.—*H. A. Pingree, M.D., Portland, Maine.*

THESIS UPON THE SUBJECT OF RADIOGRAPHING THE SPINE AND PELVIS. H. J. Suggars, *Archives of Rad. and Electrother.*, May, 1922.

This article gives details of making radiograms of spine and pelvis, and is therefore of interest chiefly to the x-ray operator. Adjustment of apparatus, proper posing of patient and placing of plate so as to get best results in the different regions, are points discussed at length. There are also practical points on developing and printing. It should be read in full by those doing such work. —*R. W. Billington, M.D., Nashville.*

ATYPICAL FORM OF OSTEOCHONDRITIS OF THE HIP. Nové-Josserand. *Revue d'Orthopédie*, March, 1922, Page 193.

Although the typical picture of osteochondritis of the hip is now well known, there are some variations to which attention should be directed. Calvé, Mérine, and others regard the affection as an epiphysitis, but numerous records of involvement of the acetabulum and neck of the femur show this conception to be too narrow and exclusive. Mouchet has called attention to three cases with irregularities of the acetabulum, and the author found that part of the joint involved, slightly but clearly, in five out of eight cases.

One of the author's cases was under observation in 1900 and at that time a diagnosis of beginning tuberculosis of the hip ws made, but in the light of present knowledge there can be no doubt, from the clinical history and progress, that it was a case of Legg-Perthes disease. The symptoms, which are described in detail, form the characteristic picture of this disease, but the roentgenogram showed in addition to the typical flattening of the femoral head, an involvement of the roof of the acetabulum. The bone here was irregular in outline and overhung the femoral head. Decalcification was also evident. The lesion in the ilium appeared before that of the head and was the predominant lesion throughout the course of the disease.

Another case, bilateral, showed decided acetabular changes on both sides. On one side the cavity was hollowed out in its lower half and on the other side the upper half was more shallow than normal, due apparently to erosion of the upper margin. Both femoral heads showed separation of the articular cartilage into segments and flattening of the normal dome. These changes were shown by roentgenograms of about nine months interval to be progressive, which observation disproves for this case at least the idea of a congenital malformation.

Case 3 showed widening and flattening of the acetabulum, bilateral, also decalcification of the bone over the upper part of the acetabulum. Flattening of the femoral head was also evident on both sides.

It has been easier to admit involvement of the femoral neck than of the acetabulum in cases of osteochondritis. A decalcification of the neck, resulting in a coxa vara, is apparent in a large number of cases. In one case, a boy of nine, a limp in left hip appeared without pain, but accompanied by limitation of abduction and internal rotation. Roentgenogram showed diffuse decalcification in the neck, the head and acetabulum appearing to be normal. After three months in a walking splint the symptoms had subsided. The neck became recalcified, but a slight coxa vara persisted. Two other cases showed very much the same thing except that in one of them no coxa vara developed.

This involvement of the femoral neck resulting in coxa vara is probably the explanation of the deformity usually spoken of as adolescent coxa vara. It is concluded that the three deformities or diseases, osteochondritis, arthritis deformans juvenilis, and adolescent coxa vara, are but varieties of the same pathologic process. The different age at which the disease appears determines the part most affected. The three cases with cervical involvement were 9½, 11, and 13 years of age, an age considerably older than cases with osteochondritis, involving the head alone, and at which the relative density of the epiphyseal cartilage is less than the articular cartilage.—*William Arthur Clark, Pasadena, Calif.*

A Case of Ossification of the Subacromial Bursa. Coulomb. *Revue d'Orthopédie*, May, 1922, page 251.

A woman of 32 had suffered for about 8 years with pain in the right shoulder, more or less acute, and augmented by movements, especially abduction of the arm. Finally the pain became almost continuous and she carried her arm in a sling. The deltoid was atrophied. There was hyperesthesia over the distribution of the circumflex nerve, and the biceps was irritated throughout its entire length. Rotation and circumduction were limited and attempts at abduction caused intense pain. A clinical diagnosis of periarthritis scapulo-humeral was made, and confirmed by the roentgenogram. The bones of shoulder-joint were normal, but under the acromion was a round, opaque mass about 2.5 cm. in diameter. At operation this was found to lie in the subacromial bursa and was made up of spongy bone with a small calcareous deposit in its center. Movement was begun in the shoulder about ten days after operation, and when seen a year later the patient was completely cured and much improved in general health.

This seems to be a rare case, especially when considered as a cure of periarthritis by operation. It was particularly favorable as an operative case, in that the trouble was localized in one bursa. Regarding the pathology, it is thought that it might be analogous to myositis ossificans, perhaps starting with a hemorrhage into the bursa.—*William Arthur Clark, Pasadena, Calif.*

Book Review

Artificial Limbs and Amputation Stumps.—A Practical Handbook by E. Muirhead Little, F.R.C.S., England. Consulting Surgeon to the Royal National Orthopaedic Hospital; Surgeon to the Royal Surgical Aid Society: Visiting Surgeon under the Ministry of Pensions to Queen Mary's Convalescent Auxiliary Hospital at Roehampton; Member of the Advisory Council, and one of the Minister's Advisers on Artificial Limbs. With Two Hundred and Sixty-Seven Illustrations. Philadelphia: P. Blakiston's Son & Co., 1922.

It is with great pleasure that we recommend the publication of this admirable little book in this country, immediately following its English printing. With the exception of the book by Broca and Ducroquet on "Artificial Limbs" and another small book by Huggins on "Amputation Stumps," there has been nothing modern published on this subject in the English language.

Mr. Little, in his capacity of Orthopaedic Consultant to the Royal National Orthopaedic Hospital and to Queen Mary's Convalescent Auxiliary Hospital at Roehampton during the war, has had a particularly rich experience in the prescription and supervision of limb fitting since the beginning of the war. This book embodies in a clear and detailed way his large experience. The major part of the book is devoted to a study of the various types of artificial limbs, which are reviewed in an interesting manner. In addition, he presents a complete description with illustrations of the official prostheses used by the British Ministry of Pensions. Mr. Little has himself been responsible for the development of a large number of these limbs and is able to speak with conviction.

The British Government, with about forty thousand cases of major amputations, has wisely devoted itself to developing its own selected apparatus to fit every type of case, and these models may be obtained from almost any of the English limb builders. The limbs used, particularly those for the lower limb, are in a general way superior to those obtainable elsewhere, and in this country (although before the war our limb builders were the best in the world), the models that have been developed on private initiative alone are not as good as those which have been developed since the war under the stimulus of Government research and coöperation on the part of limb builders and especially interested physicians.

The war has demonstrated the great ignorance of the average surgeon on the subject of artificial limbs. Those who are called upon to perform amputations must know the requirements of a good stump and how to obtain it, and in addition must be able to advise the amputé as to the best type of apparatus for him to use and where to obtain it. It is to be hoped that this book will do much to remove this present point of weakness. Its author is not to be questioned and it is to be recommended to every surgeon.—*P. D. Wilson* (Boston).

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